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MANURES:

THEIR RESPECTIVE MERITS,

FROM AN

ECONOMICAL POINT OF VIEW.

BY

A. W. CREWS.

Price Two Shillings and Sixpence.

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BY

A. W. CREWS,

Author of "Guano: its Origin, History, and Virtues," &c.

BIBLIOTHECA
AUG 1882
BODLEIANA

"Science and mechanical improvement have in these days changed the mere practice of cultivating the soil into an industrial pursuit, requiring capital, machinery, industry, skill, and perseverance in the struggle of competition. This is another great change, but we must consider it a great progress, as it demands higher efforts and a higher intelligence."

PRINCE ALBERT.

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1880.

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INTRODUCTION.

In compiling this short treatise, my aim throughout has been directed towards furnishing the reader with the *gist* of each matter placed under his observation; without subjecting him to that unnecessary circumlocution so common with many writers who undertake the manipulation of a work of this kind.

To the practical farmer, I venture to predict, this production will prove of much value, as also to the gentleman amateur agriculturist who is desirous of obtaining every information relative to each species of manure and its fertilising properties in as concise statements as possible.

Passing through such a period of depression as the agricultural community of Great Britain is in at the present time, the farmer is forced to economise as much as judiciousness will permit, and no branch of

his vocation requires more attention, in this respect, than that of "manures;" for, to possess a sound practical knowledge of each class of fertilisers, means a diminution of expenses and an augmentation of his capital.

ST. HELENS,
Feb., 1880.

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MANURES:

THEIR RESPECTIVE MERITS.

PART I.

Definition of the Word "Manure"—Nature's Modes of applying Fertilisers—History—Classification.

The judicious distribution of manures is of great importance to the practical agriculturist. If he possess a knowledge of their respective properties, he understands what particular class should be employed to produce uncommon efficacious results. We therefore find him applying the peculiar kind wanted, and no other. His ignorant neighbour, on the other hand, undergoes double the expense and labour through utilising *any* species—providing the same comes under the denomination of "manure"—to *any* sort of crop, irrespective of the fact that as the many varieties of plants vary in their constituents, different fertilising compositions are therefore requisite to furnish them with those ingredients so essential to their productiveness. To afford the reader this information is the object of this small work.

SECTION I.

Definition of the Word "Manure."

"Manure," according to our lexicographers, is contracted from the French word "man-œuvre" or "manouvrer," and originally signified "to till," "hand-work." An able writer reminds us that it is employed in this sense by Milton in "Paradise Lost," IV.

> "Yon flowery arbours . . . with branches overgrown,
> That mocks our scant manuring."

Like many other English expressions, however, its signification has changed with the sentiments of the people until we of the present generation define it as being "any substance or fertilising material applied to or incorporated with cultivated land with a view to increase its productive properties, both as regards first, its acting as a certain stimulus upon plants, as particularly seen in the case of the powerful top-dressings, nitrate of soda, &c.; and secondly, as affording a source of direct food to the plant."

SECTION II.

Nature's Modes of applying Fertilisers.

In every country, Nature supplies the land, more or less, with fertilising substances. In some districts her beneficences are much more perceptible than in others. Perhaps one of the simplest forms she has is seen in the shedding of the leaves "when autumn hath blown." Each solitary leaf that we behold whirled from its stem down through the air until it reaches the earth, assists towards forming, in time, another fresh stratum for the further purposes of mankind. One of her many bountiful acts is witnessed upon a grand scale in the periodical inundations of the river Nile in Egypt, which fertilises the whole country

stretching along its banks by its annual overflowings. In describing this remarkable feature, a writer observes: "The grand phenomenon connected with the Nile is its annual overflow of the banks which border it—an event looked for with as much certainty as the daily rising of the sun. These valuable inundations are owing to the periodical rains which fall between the tropics. They begin in March, but have no effect upon the river until three months later. Towards the end of June it begins to rise, and continues rising at the rate of about four inches a day, until the end of September, when it falls for about the same period of time. Herodotus, the Grecian historian, informs us that in his time a rise of sixteen cubits was sufficient to water the country. At present, twenty-two cubits are considered a good rise. The towns are generally built in such a situation and manner as not to be overflowed by the inundation; and in some parts of the country there are long raised causeways upon which the people may travel during the floods. It is only in cases of an extraordinary rise that any villages are destroyed. The inundations, instead of being viewed as a calamity, are considered a blessing, for they are the cause of inexhaustible fertility. After the waters have subsided, the earth is found covered with a fine fertilising mud, which has been left there by the river. The whole valley of the Nile may be considered as an alluvial plain composed of the washed-down mud and sand of Central Africa, and it is, therefore, to these inundations that Egypt owes its existence."

SECTION III.

History.

From the time that the Omnipotent Creator sent Adam "forth from the garden of Eden to till the ground," the

utilisation of manure, in some form or other, must have occurred throughout the primeval ages of mankind. Cain, we know, was "a tiller" of the soil. Noah "planted a vineyard;" and though, strictly speaking, we cannot positively assert that manure was purposely applied by the hands of man during these remote epochs, still, as "tillers" and "planters," when preparing the ground, our progenitors *must have buried beneath the surface the vegetation which existed thereon*, thus, wittingly or unwittingly, pursued a system commonly denominated "green manuring."

When the Egyptians held the reins of almost universal supremacy, they had, as now, the annual inundations of the Nile to fertilise their exhausted lands, thus causing yearly application by human agency unnecessary.

Shorn of their power, however, we pass from them to the earliest civilised ages of the Greeks, and from thence to the Romans.

From the works of such classical authors as Cicero, Cato, Theophrastus, Columella, Pliny, Homer, &c., we are enabled to perceive the high value set upon fertilisers by the earliest cultivators of these two kingdoms. "The manure chiefly employed was the dung of birds and the ordinary domestic animals (*stercus columbinum, bubulum, ovillum, caprinum, suillum, equinum, asininum*, &c.) This differed considerably in quality, according to the source from whence it was procured; and hence those who raised different kinds of crops are enjoined to keep the different sorts of dung separate, in order that each might be applied in the most advantageous manner. That derived from pigeon-houses (*columbariis*), from aviaries where thrushes were fattened (*ex aviariis turdorum et merularum*), and from birds in general, except waterfowl, was considered as the hottest and most powerful, and always placed apart, being sown by the hand exactly as we deal with guano at the

present moment. The ancient writers very emphatically point out the necessity of procuring large supplies of manure, which the Romans regarded as under the special patronage of a god named Stercutius, and farmers were urged to collect straw, weeds, leaves of all sorts, hedge clippings, and tender twigs, which were first used to litter the stock, and then, when mixed with ashes, sweepings of the house, road scrapings, and filth of every description, served to swell the dunghills (*sterquilinia*). These were at least two in number, one being intended for immediate use, the other for the reception of fresh materials, which were allowed to remain for a year; dung, when old and well rotted, being accounted best for all purposes, except for top-dressing of meadows, when it was used as fresh as possible. The dunghills were formed on ground that had been hollowed out and beaten down or paved, so that the moisture might not escape through the soil, and they were covered over with brushwood or hurdles to prevent evaporation. In this way the whole mass was kept constantly moist, and fermentation was still further promoted by turning it over very frequently and incorporating the different parts. . . . A full manuring (*stercoratio*) for a juger of land on an upland slope (*quod spissus stercoratur*) was 24 loads (*vehes*), each load being 80 modii or pecks; while for low-lying land (*quod rarius stercoratur*) 18 loads were considered sufficient. The dung was thrown down in small heaps of the bulk of five modii, it was then broken small, was spread out equally and ploughed in instantly that it might not be dried up by the rays of the sun, great care being taken to perform these operations when the moon was waning, and if possible with a west wind. According to the calculations of Columella, an ordinary farm ought to yield 1440 loads per year; that is, enough for manuring 60 jugers at the rate of 24 loads to the juger. In what proportion this was distributed is nowhere

very clearly defined, and must necessarily have varied according to circumstances. If we take two statements of Cato in connection with each other, we shall be led to conclude that he advises one-half of the whole manure made upon a farm to be applied to the raising of green crops used as fodder (*pabulum*), one-fourth to the top-dressing of meadows, and the remaining one-fourth to the olives and fruit trees. Columella recommends the manuring of light soils (*exilis terra*) before the second ploughing; but when rich lands were summer fallowed previous to a corn crop, no manure was considered requisite. . . . The system of manuring by penning and feeding sheep upon a limited space of ground was neither unknown nor neglected. . . . The ashes obtained by burning weeds, bushes, prunings, or any sort of superfluous wood, were found to have the best effect (Virgil, Columella, Pliny), and sometimes, as we know from Virgil, it was deemed profitable to set fire to the stubble standing in the fields. Caustic lime was used as a fertiliser by some of the tribes of Transalpine Gaul in the time of Pliny, but in Italy its application seems to have been confined to vines, olives, and cherry trees. . . . When ordinary manure could not be procured in sufficient quantity, a scheme was resorted to which was at one time pursued in this country, and is still adopted with considerable success in many parts of Italy and the sandy tracts of southern France. The field was sown about the middle of September with beans and lupins, which were ploughed into the ground the following spring, in all cases before the pod was fully formed, and at an earlier stage of their growth on light than on stiff soils. Nay, many crops, such as peas, beans, lentils, lupines, vetches, even when allowed to come to maturity, were supposed to exercise an ameliorating influence, providing their roots were immediately buried by the plough, although perhaps in this case the beneficial effects may have resulted from the

manure applied before they were sown. On the other hand, corn in general, poppies, fenugreek, and all crops pulled up by the roots, such as cicer and flax, was supposed to exhaust the soil, which then required either repose or manure to restore its powers:" (Smith.) We are reminded by Pliny that in Homer an old king is represented spreading manure on one of his fields with his own hands; and we are further assured that the mixing of different species of soil, for strewing over the land, was not an uncommon occurrence.

History informs us it was whilst Rome ruled as mistress of the world that Albion succumbed to her invincible legions. And as they found our progenitors, "the ancient Britons," "savage as the wilds in which they dwelt," we must naturally expect to find the agriculture of this country, at that period, to be in a rude, primitive condition. It is scarcely within the province of this brief work to reiterate what any history of England reveals to us relative to the further progress of agriculture in this country; therefore I pass on to the date when "artificial" fertilisers first began to make their appearance in the agricultural market.

In 1721, two geniuses "originated" a "most wonderful" fertiliser. Witness their modest advertisement as inserted in the register of inventions:

A.D. 1721, November 8th.

Piper, John, and Tindale, Matthew.—A certain compound, never before made use of, consisting of prepared chalk and sea water, which abundantly encreaseth all manner of grain, pulse, and grass beyond whatever hath been known, and what may be of great service to our subjects in generall, the said petitioners, having tried the experiments, can prove that from one barley corne setting it hath produced eighty to one hundred large shoots, each having great ears of corne, the same still growing, and by the said petitioners ready to be produced.

Concomitantly with this observe the annexed, registered in the year 1729:

Liveing, Thomas.—A method of making a compound manure for enriching and mending all sorts of land at one third part of the expence lesse than in the common method of manuring land amounts to, not only from the cheapness, but also for goodness in causing the land to produce one third in quantity more than any other manure, and by preserving the wheat from smutt, and killing the grubbs, which sometimes destroy whole fields of corne; and it is also of that richnesse in its nature as to preserve the land for three years without any other manure, as hath been experienced by several substantial farmers, who are resolved to dress all their land therewith, and have bespoke large quantities for that purpose. That the said compound manure will not only be beneficial to our subjects, but will also greatly augment our revenue; some of the ingredients thereof, which are never used for the purposes above mentioned by any other person, pays so great a duty, that for every eight bushells of the said compound which is used in dressing an acre of land, the duty will amount to seven shillings at least. That as the common method of manuring of land is become so expensive in most parts of our kingdom, which the meaner sort are not able to bear, by reason whereof their lands does not produce above one third of the crop as it would if well manured, whereby many of our poore subjects labour under great hardships, and several cattle many times perish by the severities of the winter for want of hay and straw.

In no trade is duplicity more exhibited than in the manufacture of "artificial" fertilisers, and, from the first compound registered to the very last, the whole list abounds in worthless preparations to such an extent as ofttimes causes many agriculturists to abstain altogether from using any "artificial" composition, thus making the innocent suffer for the guilty. To the unscientific farmer who does not possess the abilities and means of analysing any sample previous to purchasing the same, the only excellent advice he can receive is to buy only of those firms whose integrity *is* established.

SECTION IV.

CLASSIFICATION.

AFTER mature deliberation, I have determined upon dividing the family of manures into three classes, viz.:

1st. Vegetable,
2nd. Animal, and
3rd. Miscellaneous.

1st. VEGETABLE. — The following comprise this class: The Value of Ploughing down Green Crops—Weeds —Sea-weeds — Straw — Sawdust—Tanners' Bark— Wood-ashes — Peat — Rape-cake — Hemp, Poppy, Cotton, and Cocoanut Cakes—Bran—Malt-dust— Brewers' Grains—Coal—Soot—Charcoal.

2nd. ANIMAL.—This consists of: Dead Animals—Fish— Blood—Animalised Charcoal — Bones — Woollen Rags, Hairs, Feathers, &c.—Night-soil—Farmyard Dung—Guano.

3rd. MISCELLANEOUS.—In this are comprehended: Salts of Ammonia—Salts of Magnesia—Salts of Potash —Salts of Soda—Common Salt—Lime, and its Compounds—"Ooze."

PART II.

VEGETABLE MANURES.

THE VALUE OF PLOUGHING DOWN GREEN CROPS—WEEDS—SEA-WEED—STRAW—SAWDUST—TANNERS' BARK—WOOD-ASHES—PEAT—RAPE-CAKE—HEMP, POPPY, COTTON, AND COCOANUT CAKES—BRAN—MALT-DUST—BREWERS' GRAINS—COAL—SOOT—CHARCOAL.

As plants are found by chemical analysis to be composed of oxygen, hydrogen, carbon, and nitrogen, with a small portion of saline bodies, we thus comprehend that all vegetable substances must form excellent manures, and it is to be regretted that this class of fertilisers receives such little attention at the hands of the British agriculturist.

SECTION I.

THE VALUE OF PLOUGHING DOWN GREEN CROPS.

IN commencing the subject of Vegetable Manures, the ploughing down of green crops naturally claims our first attention.

As we are all aware, the best corn is produced where the richest turf has been ploughed in; and that where the land brought forth a strong growth of red clover, there will wheat most assuredly follow as an uncommonly excellent crop. And yet farmers in England, as a rule,

bestow little attention upon this important matter—though tending, as it does, towards reducing their expenses somewhat considerably. "In Tuscany," our writer assures us, "the white lupin is ploughed in; in parts of France, the bean and the vetch; in Germany, borage; and upon sandy soils in Holstein, spurry. The *Madia sativa* has lately been tried as a green manure in Silesia. It is sown in June, and is ploughed in, when two feet high, in October. Sheep do not eat it, so that if a flock of sheep be turned in, they eat up the weeds and trample down the madia, after which it is easily ploughed in. In a month it is rotten, and the land may be cross-ploughed, and the winter corn sown.

"In French Flanders, two crops of clover are cut, and the third is ploughed in. In some parts of the United States, the clover is never cut, but is ploughed in as the only manure; in some parts, the first crop is cut and the second ploughed in. In some of the northern States, Indian corn is sown upon poor lands, at the rate of four to six bushels an acre, and two, or sometimes three, such crops are turned in during the summer. In north-eastern China, a species of coronilla and a trefoil are specially sown and grown in ridges, as a manure for the rice crop. They are ploughed and harrowed in before the young plants are put into the flooded land.

"In Sussex, and in parts of Scotland, turnip seed has been sown at the end of harvest, and after two months again ploughed in, with great benefit to the land. Wild mustard, also, which grows so abundantly as a weed on many of our corn-fields, is not unfrequently raised for ploughing in green. White mustard is sown in Norfolk, and ploughed in as a preparation for wheat; sometimes, also, on the stubble, as a preparation for turnips. It is said to destroy the wire-worm. Turnip leaves and potato tops decay more readily and more perfectly, and

are more enriching when buried in the green state. It is a prudent economy, therefore, where circumstances admit of it, to bury the potato tops on the spot from which the potatoes are raised.* Since the time of the Romans, it has been the custom to bury the cuttings of the vine stocks at the roots of the vines themselves; and many vineyards flourish for a succession of years without any other manuring. In the Weald of Kent the prunings of the hop vine, chopped and dug in, or made into a compost and applied to the roots of the hop, give a larger crop, and with half the manure, than when they are burned or thrown away, as is usually done.

"That the soil should be richer in vegetable matter after this burial of a crop than it was before the seed of that crop was sown, and should also be otherwise benefited, will be understood by recollecting that perhaps three-fourths of the whole organic matter we bury has been derived from the air—that by this process of ploughing in, the vegetable matter is more equally diffused through the whole soil, than it could ever be by any merely mechanical means—and that by the natural decay of this vegetable matter, ammonia and nitric acid are, to a great extent, produced in the soil, and its agricultural capabilities in consequence materially increased. Indeed, *a green crop ploughed in is believed, by some practical men, to enrich the soil as much as the droppings of cattle from a quantity of green food three times as great.*

" These considerations, while they explain the effect and illustrate the value of green manuring, will also satisfy the intelligent agriculturist that there exist methods of

* By taking off the blossoms of potatoes—besides the usual increase of crop—the tops keep green till the potatoes are lifted. Thus much green matter is obtained; and if this be made into manure, and applied to the next potato crop, it is said to raise the largest produce of tubers.

improving his land without the aid either of town or of foreign manures—and that he overlooks an important natural means of wealth who neglects the green sods and the crops of weeds that flourish by his hedgerows and ditches. Left to themselves, they will ripen their seeds, and sow them annually in his fields; collected in compost heaps they will naturally add to his yearly crop of corn."

All succulent plants contain a quantity of saccharine or mucilaginous matter; and when undergoing putrefaction, the gases emitted invariably appear—if buried in a green state—to prove highly nourishing and invigorating to the succeeding crop. The woody fibre, starch, sugar, and gum, being compounds of carbon, hydrogen, and oxygen; the fixed and volatile oils being constituted of carbon in conjunction with the components of water, and an excess of hydrogen; and the albumen and gluten containing nitrogen as a constituent, we thus perceive, here present, all the principal elements necessary for the development of the future plant. In describing this action, Sir H. Davy observes: "The decomposition slowly proceeds beneath the soil, the soluble matters are gradually dissolved, and the slight fermentation that goes on, checked by the want of a free communication of air, tends to render the woody fibre soluble without occasioning the rapid dissipation of elastic matter." The same eminent authority continues: "When old pastures are broken up and made arable, not only has the soil been enriched by the death and slow decay of the plants, which have left soluble matters in the soil, but the roots and leaves of the grasses living at the same time, and occupying so large a part of the surface, afford saccharine, mucilaginous, and extractive matters, which become immediately the food of the crop, and the gradual decomposition affords a supply for successive years."

In some districts, lime and peat, mixed together, are spread upon the field previous to the ploughing in of the

green crop, "that the decay of the vegetable fibre may be more speedily promoted;" but in opposition to this process, even the applicants themselves confess that, on the whole, the advantages gained by such a course are "doubtful;" for, "although the quantity of nutritive matter may be increased, the expense of the acquisition seems too great."

We have all heard of the famed lands in some parts of America, which, year after year, in consecutive succession, furnish its labourers with such magnificent crops, and this after but the barest scratchings over of the surface, and without the slightest addition of manure by manual labour. How is this brought about but through the accumulation of vegetable mould for unknown ages—until now the soil is one fine mould of vegetable and earthy matters, only requiring the presence of the seed to bring forth some of the finest crops producible.

SECTION II.

Weeds.

Nearly all authors who have written upon the subject of agriculture, whether in ancient or in modern times, have dwelt upon the advantages accrued through collecting all vegetable matters obtainable—thistles, groundsels, in fact weeds of every kind—to form manure either by (1) turning in whilst green; (2) depositing in a heap to undergo decomposition; or (3) to undergo the process of burning, or, to use a more suitable term, "charring."

Amongst the many purposes served by applying vegetable matters according to the first mode, three advantageous circumstances place themselves prominently forward, viz., first, the pores of the land become opened, thereby making it lighter and more friable than hitherto;

secondly, organic food becomes supplied to the roots of the plants; and, thirdly, saline and earthy matters are yielded to the roots in a state peculiarly adaptable for stimulating the vascular system, and otherwise benefiting the growth of the crop.

Respecting the second plan, it is highly essential that the various matters be well mixed, thrown together as lightly as possible, and, if a dry season, sprinkling the heap over with water will prove of benefit. Many farmers introduce to the substance a small quantity of lime or peat earth, and incorporate the whole whilst undergoing the process of solution. By such a procedure, the bulk of the compost is not only increased, but its value is also materially enhanced. Those agriculturists who pursue this method ofttimes confine the use of this fertiliser to those fields prepared for barley, or for plots of ground upon which turnip seed is to be sown broadcast.

When subjected to the third process, we receive the residuum in the form of "ash." This substance contains alumina, silica, oxide of iron, lime, magnesia, oxide of manganese, potash, partly in a state of silicate, soda, sulphates of lime and potash, chloride of sodium, carbonates of potash, lime, and magnesia, with a certain proportion of charcoal. Now as this table contains the same constituents as generally held in the ash of those crops usually cultivated in these regions, we can discern the value of this composition for fertilising purposes. Being in a powdery state, it can consequently either be scattered along the drills, strewn over the ground like any other pulverised manure, or mixed as an ingredient with any other composition likely to be utilised as a fertiliser.

There is one matter, however, the farmer should be cautious about, and that is, whenever vegetable matters are being "burnt," the process should be conducted as slowly as possible; for by such a regulation more carbon

or charcoal is preserved in the ash, and, as generally known, this ingredient constitutes one of the most valuable components contained therein. Almost any vegetable will admit of being charred; and if mixed, when in this state, with urine, the compound forms a most powerful fertiliser.

SECTION III.

Sea-weed.

As generally comprehended, there are different varieties of "sea-weed," all of which vary very essentially in their constituents. The *Fucus vesiculosus*, which is distinguishable by its leaves, contains, when dry, about eighty-four per cent. of vegetable matter, thirteen per cent. of sulphate of lime and magnesia, with a little phosphate of lime, and thirteen per cent. of muriate and sulphate of soda.

The *Fuci saccharinus* and *digitatus*, when subjected to analysis, have been found to hold the following substances: Mucilage, saccharine matter, vegetable albumen, sulphate of soda, oxalate of potash, muriate of soda, muriate of potash, sulphate of magnesia, carbonate of soda, carbonate of potash, oxide of iron, phosphate of lime, phosphate of magnesia, hydriodate of potash, and silica.

The *Laminaria* ("those long tawny-green, ribbon-like algæ"), so common on the British coast, contain, in addition to vegetable matter and soda, a large proportion of the salts of potash. In some species of sea-weed, however, no salts of potash can be traced.

With the exception, perhaps, of clover of the first year's growth, sea-weed may very justly be reckoned as adaptable, more or less, for all crops. Therefore, wherever attainable, farmers eagerly embrace any opportunity that

will permit them to obtain a quantity of this valuable substance. From a work published during the seventeenth century, it appears that in the island of Jersey, at that period, the sea-weed growing upon the rocks along the shore was only permitted to be cut twice each year. When either of the two seasons was at hand, by order of the magistrate, a town crier proclaimed to the people on the previous market day that, at a certain day, the summer or winter crop would be gathered, when those who desired to obtain any were enjoined to assist. If in stormy weather, however, quantities of the weed should be cast ashore, it was eagerly pounced upon by the lucky husbandman.

A gentleman of undoubtable authority asserts that the farms on the Lothian coast let for 20*s.* or 30*s.* more rent per acre when they have a right of way to the sea, where the sea-weed is thrown ashore. And in the same locality sixteen loads of the weed are reckoned equal to twenty tons of farm-yard manure. We are further assured that the agricultural produce of the Isle of Thanet, in Kent, is said to have been doubled or tripled by the use of this manure, also, that in the Western Isles "the sea-ware, the shell-marl, and the peat-ash, are the three great natural fertilisers, to which the agriculture of this remote region is indebted for the comparative prosperity to which it has in some of the islands attained."

Quoting from the same authority, "At Oban, on the west coast of Scotland, the fishermen bring it in their boats, and sell it on the shore at a shilling a cart. One cart is there reckoned equal to two of farm-yard dung for raising potatoes. Used alone for this crop, it gives a good return, but generally of inferior quality.* On the south-

* The potatoes are said to be of better quality when the sea-weed is put into the soil and covered with a layer of earth, upon which the potatoes are to be planted.

east coast of Fife, where the sea-weed is laid on the stubble at the rate of twenty carts an imperial acre, ploughed in, and the turnips afterwards raised with half dung, *the clover is said never to fail.* Laid on bean stubble, and ploughed in, twenty-seven cart-loads gave, in Suffolk, three times as much wheat as five bushels of salt and fifteen loads of farm-yard manure per acre."

The effects of sea-weed, as a fertiliser, are transient—that is, do not last longer than a single season, which is accounted for by the large proportion of water or the elements thereof, which it holds. Farmers utilise this substance for fertilising purposes in the three similar methods as "weeds" (*vide* preceding section) — viz., either by ploughing it in while fresh, placing it into a heap for future use, or by burning it in the same manner as other vegetable matter, and using the ash as a fertiliser.

In reference to the plan of burying it in while fresh, many practical men consider this mode much more advantageous than if permitted to become decomposed in the compost heap. Their reasons are that as this substance decays without producing heat when exposed to the atmosphere, and seems, as it were, to dissolve away, they consider that it should be applied as fresh as possible, and believe that the practical results of this system are entirely in accordance with the theory of its operation. They further argue that "the carbonic acid formed by its incipient fermentation, must be partly dissolved by the water which is set free in the same process, and thus becomes capable of being absorbed by the roots of plants. As a manure, the effects of sea-weed must depend on this carbonic acid, and on the soluble mucilage which it may contain. Some fucus has been found to have lost half its weight by fermentation, and afforded less than one-twelfth of mucilaginous matter; from this we may conclude that

some of this substance is destroyed in the course of fermentation." It is also considered that when used immediately whilst in a fresh state, many of the marine ingredients are peculiarly noxious to the vermin which exist in all cultivated soils. If this be true, the practice of placing the weed into a mass and there allowing it to become decomposed, must be therefore decidedly injudicious. The main support on which the upholders of the latter plan (of "allowing all vegetable matters to become decomposed in a heap previous to being employed upon the land") rest upon, is that by such a course all seeds contained in the weeds are killed by this procedure. But with respect to sea-weed, they can have no base to stand on, for as pretty well understood, the seeds of marine weeds will not grow on arable upland soils.

On rich and poor soils alike, sea-weed is invariably adaptable. Even on the poorest kinds of heath lands, the fertilising effects of this substance, have exhibited themselves most prominently. According to one account "crops almost incredible, of turnips, barley, clover, and rye, have, to the writer's certain knowledge, been obtained on an extensive tract of the most miserable benty wastes and poor rabbit warrens, by the powers of this manure; soils which twelve years since, were not worth three shillings per acre. The bent was torn up by the common swing plough, burnt, and the ashes spread; the soil was then manured with the sea-tang, as much as could be ploughed in. Turnips were immediately drilled and rolled to prevent blowing; this crop was succeeded by rye or barley, and that by red clover and rye grass. On the clover stubbles, and sometimes after the turnip crop, plenty of tang was again laid, the ley ploughed down and sown with oats, barley, or rye, and frequently with turnips, which in this way have succeeded admirably on the ley with one ploughing."

The value of this manure as an improver of old pastures is generally admitted. It may be either used individually as a top-dressing, or, as in some instances, mixed up with fresh dung and thus applied. Both cattle and sheep eat with avidity the new grass, which is quickly produced, and these animals have been found, by experience, to thrive well and fatten quicker by such a procedure.

Some persons advocate the system of cultivating the weed on the sea-coast, expressly for the purpose of cutting therefrom for agricultural use. It is affirmed that nothing further is required than simply placing stones on the shore, when the fuci attach themselves to the latter spontaneously; and in two years may be cut. Various kinds of stones are recommended, the class considered as best adapted being the limestone, then the basalt, and after that the sandstone.

When sea-weed undergoes the act of burning, the kelp and barilla of commerce are formed. As these ashes contain a quantity of potash in conjunction with the soda and other vegetable ingredients, they may naturally be expected to operate by rendering vegetable matter soluble, and a suitable food for plants; but from various experiments they seem to possess other properties as fertilisers. Although many farmers recommend "sea-weed ash" to be distributed as a dressing by itself; others are of opinion that it is more judicious to mix it into a compost with other substances. In support of this principle, one gentleman, in describing the effects of kelp applied without an admixture of any other compound, observes: "120 bushels were allowed to the acre, and distributed in the drills. When the turnips sprouted, they had an unhealthy green or rather yellowish appearance, but after some time several patches in the field seemed to be growing luxuriously, while others seemed to retain their sickly hue. Upon a careful examination, it was discovered that

wherever the ground was deepest, and the ashes of the sea-weed had been mixed up with the soil, the turnips were best; and, on the other hand, that where the ashes, not being mixed up with the soil, came in contact with the seed, the turnips did not at all thrive." Good earth or moss will be found a first-rate ingredient to be incorporated with the ash, or animal and vegetable manures mixed with the same substance will form a still more powerful fertiliser. Many agriculturists give their opinion that 5cwt. of kelp is quite sufficient per acre; others consider a ton to be more suitable; but in the generality of cases, the first amount (5cwt.) will be found ample.

SECTION IV.

Straw.

Like all vegetable matter, straw decays but slowly. It is therefore considered best to mix it into a compost with other substances already more or less advanced towards decomposition. "Heaps of dry straw," says Mr. Johnston, "when alone, or even when mixed with earth, will ferment with comparative difficulty, and with great slowness. It is necessary, therefore, to mix it, as is usually done, with some substance that ferments more readily, and which will impart its own fermenting state to the straw. Animal matters of any kind, such as the urine and droppings of cattle, are of this character; and it is by admixture with these that the straw which is trodden down in the farm-yard is made to undergo a more or less rapid fermentation.

"The object of this fermentation is two-fold—first, to reduce the particles of the straw to such a minute state of division, that they may admit of being diffused through the

soil; and second, that the dry vegetable matter may be so changed by exposure to the air and other agencies, as to be fitted to yield without difficulty both organic and inorganic food to the roots of the plants it is intended to nourish.

"Differences of opinion have prevailed, and discussions have taken place as to the relative efficacy of long and short, or of half fermented and fully rotten dung. But if it be added *solely* for the purpose of yielding food to the plant, or of preparing food for it, the case is very simple. The more complete the state of fermentation, if not carried too far, the more immediate will be the agency of the manure—hence the propriety of the application of short dung to turnips and other plants it is desirable to bring rapidly forward; but if the manure be only half decayed, it will require time in the soil to complete the decomposition, so that its action will be more gradual and prolonged.

"Though in the latter case the immediate action is not so perceptible, yet the ultimate benefit to the soil and to the crops may be even greater, supposing them to be such as require more special forcing at one period of the year. This is easily understood. While it is undergoing fermentation in the farm-yard, the straw loses part of its substance—either in the state of gaseous matter, which escapes into the air—or of saline matter, which is washed out in the liquid form. Thus, after complete fermentation, the quantity of matter present is really less, and, consequently, when added to the soil, though the *immediate* effect upon the crop be greater, the *whole* effect may also be very considerably less.

"This will appear more clearly when it is considered that the quantity of recent dung—mixed straw and cow dung—is, by experiment, equal on an average to two or two and a half times that of the dry food and fodder taken

together, while, when fully rotten, the weight of the dung may be no greater than that of the dry food and fodder consumed by the cattle.

"Thus it has been found that one ton of dry food and straw gives a quantity of farmyard dung which weighs:

When recent	46 to 50 cwt.
After six weeks...	40 „ 44 „
After eight weeks	38 „ 40 „
When half rotten	30 „ 35 „
When fully rotten	20 „ 25 „

A part of this loss may, no doubt, be ascribed to the evaporation of a portion of the water of the recent dung; but the larger part is due to an actual escape of the substance of the manure itself. The farmer, therefore, who applies the manure from a given weight of food and straw, in a fresh state, adds more to his land than if he first allows it to become perfectly fermented. Where he to chop his straw, and put it in as it comes fresh from the field, he would add still more; but its action as a manure would be slower, and while it would beneficially open stiff and heavy soils, it would injure others by rendering them too light and porous,"

One gentleman, experimenting with straw, employed it in the following manner: Upon the same kind of soil, he manured one portion with a mixture of dung and straw "highly putrified;" the other with the same compost "newly made, and the straw almost fresh." Upon the first year after application the best crop was found to be produced by the decomposed manure; but the second year, the undecomposed produced the best effect; the same result followed the third year, after which, both portions of the land appeared to be equally exhausted. We thus perceive that the drier the substance is when applied to the ground, the more prolongued will the period be ere its effects exhibit themselves; therefore, when we

apply fresh straw or any other dry matter to the land, we must expect scarcely any benefit to accrue from its employment during the first season; but look to the second and third year subsequent to its application.

SECTION V.

Sawdust.

Many farmers are known to entertain a feeling of prejudice against the use of this substance as a fertiliser; and in some districts, owners of horses, who mix sawdust with their stable-dung, sometimes complain that they experience much difficulty in effecting a sale of the manure when so incorporated. The plea of the farmers is that it breeds wire-worm; and also as a manure, it is so exceedingly slow in its decomposition that they cannot perceive any pecuniary benefit to be derived by its application. That it decomposes but slowly when ploughed into the land is universally acknowledged; but as a gradual benefitter of the land, it is certainly deserving of more attention than is now generally bestowed upon it. By its use, heavy soils are rendered more light and porous. If liberally applied to such lands, its effects will been seen but slightly the first year, a little more during the second, still more during the third, and most of all in the fourth year succeeding its employment.

For the benefit of agriculturists who grow cucumbers for market purposes, it may be interesting to know that some of the finest crops of this vegetable have been grown with the aid of sawdust. In describing this mode, one writer tells us: "The bottom of a wet sheepyard was covered 2ft. deep with oak, elm, and ash sawdust. After having lain there two years, it was cleaned out and employed for

heating. The cucumbers were planted in this with no other soil, and the result was the largest crop I ever saw. Sawdust from a stable when cleared out ought to be put into a wet hole, and should lie there two years before being used."

With liquid manures, sawdust forms an excellent absorbent, preserving the liquids from sinking too rapidly in sandy, chalky, or any other porous soil; whilst, simultaneously, the liquids act upon the sawdust, hastening its decomposition, thereby producing its more immediate effect upon the land.

As an adjunct to other fertilisers, sawdust has lately been brought prominently into notice: its usefulness cannot be doubted when added to putrefying vegetable or animal substances. If the land be not too rich in vegetable matters already, such a compost will be found of immediate and lasting benefit.

Some agriculturalists pursue the plan of "charring" sawdust, either by "burning" or by alternate layers of quick lime—and when so applied, its influences upon the soil become much exhanced.

The system of mixing sawdust "with sheep's dung, urine, slaughterhouse, and fish offal, is, perhaps, the most deserving of consideration, because the fermentative qualities of such articles are the best adapted to overcome the comparatively indestructive nature of the dust. Hitherto the great objection to sawings of wood as manure has been their slow decomposition. Immediate activity is necessary to give value to manure, and this is what sawdust does not possess. Excrementary and offal matters, on the contrary, are from their nature subject to rapid decomposition, so much so, that half their fertilising value is not unfrequently lost. Indeed, it is impossible to estimate the loss arising from this source. Now, if the mixing of the two together will effect the decomposition of the former,

while it avoids the loss sustained in the latter, the gain must consequently be great.

"What gives peculiar value to composts of this kind is their disintegrated state: they are fit for drilling in along with the seed by corn and turnip drills at once. Their freeness from sand and other heavy and comparatively useless mineral substances is another merit. The difference between the expense of applying farmyard manure and guano, for instance, is considerable, while the advantages gained by expedition in seed time are even of greater importance. The addition of 50 per cent. of sand and clay (as when urine, fish-gut, &c., were mixed with earth) doubles the expense and time of application; and this, if the distance is great, may exceed the value of the manure itself. "The prime cost of the article would be little more than the carriage, while in most localities the supply would obviously be great. We have only to examine our timber yards for evidence of this. How many ingenious plans have ever been contrived for carrying the sawdust down the stream which drives the saw mill, or in the fire of the steam engine where steam power is used.

"Now that agricultural manures have become a necessity, it is the duty as well as the interest of everyone to look first to the resources within his own reach for a supply, and *lastly* to the market for any balance required. To neglect the former, relying entirely upon the latter for Peruvian guano, &c., and then complain of high prices, is inconsistency and folly. Were every farmer to procure annually so many tons of sawdust, which could be had for little money, and to mix it with the excrements of horses, cattle, sheep, pigs, poultry, &c., adding such other articles as peculiar circumstances required, it would exercise a very salutary effect upon the extravagant prices now paid for all kinds of artificial manures. If a farmer can thus manufacture at home as good an article for 20*s.* as he can

purchase for 5*l.* (and this can be done in many cases), the course whence he ought to steer is plain:" (Editor, *Agricultural Gazette.*)

SECTION VI.

TANNERS' BARK.

TANNER'S BARK has been recommended by various authors as a substance which may be rendered capable of affording nutriment to vegetation.

When subjected to analysis, the ash of the barks of the poplar, oak, hazel, hornbeam, and mulberry respectively, were found to contain the following components:

	Poplar.	Oak.	Hazel.	Hornbeam.	Mulberry.
Earthy carbonates...	60·	66·	54·	59·	45·
Earthy phosphates...	5·3	3·	5·5	4·5	8·5
Soluble salts	6·	7·	12·5	4·5	7·
Metallic oxides	1·5	2·	1·75	0·12	1·12
Silica	4·	1·5	0.25	1·5	15·12

The agriculturist will comprehend that the saline and earthy constituents of the barks of these and other forest trees must possess some considerable merits as fertilisers; "it is only to the slowness with which tanner's bark undergoes putrefraction that its neglect by the cultivator must be attributed." Adverting to this subject an eminent author observes: "Like sawdust and peat, this substance is difficult to work up, and is therefore often permitted largely to go to waste. Like peat, it may be dried and burnt for the ash, which is light, portable, and affords a valuable top-dressing. But the economist will prefer to ferment it in a compost . . . . an occasional watering of the compost with the liquid manure of the farmyard will bring it into a heat, and when the ammoniacal liquor of the gasworks can be procured at a cheap rate, it may be employed for a similar purpose. The hard thick fragments of the bark, however, cannot be so soon decomposed

as the already finely divided peat, and must be expected therefore to demand more time. With lime, it may, like sawdust or peat, be reduced and charred."

Stable dung is most suitably adapted for mixing with the bark to enable it to undergo more quickly the process of fermentation. The addition of lime will assist still further towards disintegrating the woody fibres. When in a half decomposed, or even fresh state, this compost has produced most excellent effects when distributed as a top-dressing to grass lands.

SECTION VII.

Wood-Ashes.

The high value of wood-ashes as a fertiliser is known to all agriculturists.

According to a writer of authority: 1000 parts of the wood of various trees, when subjected to the process of "burning," yielded the following parts of ashes:

				Parts of ashes.
1000	parts of	the dry wood of a young oak	yielded	2
1000	,,	bark of oak	,,	60
1000	,,	perfect oak wood	,,	2
1000	,,	poplar wood	,,	8
1000	,,	ditto bark	,,	72
1000	,,	wood of hazel	,,	5
1000	,,	bark of ditto	,,	62
1000	,,	wood of mulberry	,,	7
1000	,,	bark of ditto	,,	89
1000	,,	wood of hornbeam	,,	6
1000	,,	bark of ditto	,,	134
1000	,,	wood of horse chesnut	,,	35
1000	,,	straw of wheat	,,	43
1000	,,	branches of the pine	,,	15

The above table will prove of immense advantage to the agriculturist who possesses facilities for providing himself with a supply of wood-ash from any class of trees. He

will discern at a glance that the bark of each tribe yields a much greater quantity of ash than do its other portions.

100 parts of these ashes were found to consist of the following substances in varying proportions :

	Soluble Salts.	Earthy Phosphates.	Earthy Carbonates.	Silica.	Metallic Oxides.	Loss.
100 parts of ashes of young oak dry wood contains ...	26·	28·5	12·25	0·12	1·	·58
100 „ „ bark of „ ...	7·	4·5	63·25	0·25	1·75	22·75
100 „ „ perfect oak wood „ ...	38·6	4·5	32·	2·	2·25	20·65
100 „ „ poplar wood „ ...	—	16·75	27·	3·3	1·5	24·5
100 „ „ „ bark „ ...	6·	5·8	60·	4·	1·5	23·2
100 „ „ wood of the hazel „ ...	24·5	35·	8·	0·25	0·12	32·2
100 „ „ bark „ ...	12·5	5·5	54·	0·25	1·75	26·
100 „ „ mulberry wood (cut in November) ... ... contains ...	21·	2·25	56·	0·12	0·25	20·38
100 parts of ashes of bark wood (cut in Nov.) „ ...	7·	8·5	45·	15·25	1·12	23·13
100 „ „ wood of hornbeam „ ...	22·	23·	26·	0·12	2·25	26·63
100 „ „ bark „ ...	4·5	4·5	59·	1·5	0·12	30·38
100 „ „ wood of chesnut „ ...	9·5	—	—	—	—	—
100 „ „ straw of wheat „ ...	22·5	6·2	1·	61·5	1·	7·8
100 „ „ branches of the pine „ ...	15·	—	—	—	—	—

"The soluble salts of these ashes," the same author continues, "are chiefly carbonate and muriate of potash. The earthy phosphates are the phosphates of lime and magnesia (or the principal salt of bones); the earthy carbonates are those of lime (chalk) and magnesia; silica is the pure earth of flint; and the oxides were those of iron and manganese. . . . . Wood-ashes contain a considerable portion of carbonate of potash, a salt which is more or less present in all vegetable substances, and for which, therefore, it must be highly serviceable as a food. The carbonate of potash, too, promotes the dissolution of dead vegetable substances, and it also, from its attraction of moisture from the atmosphere, must promote an increased supply to the soil. Wood-ashes are often very judiciously added to common manure, the quality of which is improved by the mixture. The leaves of trees, when burnt, generally produce more ashes, or potashes as they are called (from being formerly produced by burning vegetable substances in large open pots) than branches, and the stem of the tree the least of all; herbs produce four or five times, and shrubs three or four times as much as either. All vegetables produce more ashes if burnt when green than when they are previously dried."

The following table by Sir H. Davy illustrates the potash produced from various kinds of vegetables, when subjected to "burning":

			Parts of potashes.
10,000 parts of the	vine	produced	55
10,000 „	thistle	„	53
10,000 „	fern	„	62
10,000 „	cow-thistle	„	196
10,000 „	bean	„	200
10,000 „	vetch	„	275
10,000 „	wormwood	„	730
10,000 „	fulmitory	„	790

As much of the fertilising properties of wood-ashes

depend upon the quantity of charcoal which they contain, the wood, for this reason, should not be too much burnt. To those soils deficient in the phosphates, the ashes of the beech form an excellent manure. On those grounds infested with the maggot, especially where carrots, &c., in consequence, cannot be grown, by scattering a quantity of these ashes over the surface, the soil will almost invariably be cleared from these pests. Applied at the rate of forty bushels to the acre, they eradicate all mosses and weeds, and renovate the grass lands to a marvellous extent, while as an extirpator of the fly upon turnips, wood-ashes are well known as one of the safest specifics.

SECTION VIII.

Peat.

Peat, or turf as it is sometimes termed, is the natural accumulation of vegetable matters for unknown ages.

In all marshes, from the earliest generation, mosses and other moisture-loving plants have been produced, increased, and decayed, until at length we behold these immense tracts of vegetable remains so common in many parts of the world, and nowhere more abundant, perhaps, than in certain districts of the British Isles.

When applied alone, peat does not appear to possess such fertilising virtues as might be anticipated from its nature; but mixed with other ingredients, it forms some of the most efficacious composts extant. Preliminary, however, to expounding these composts and their constituents, let us see what components are contained in the various specimens of peat so often brought before our notice. One sample analysed whilst in a dry state was determined to be composed as follows:

	Parts.
Inert vegetable matter	289
Fine silicious sand	29
Alumina	14
Soluble vegetable matter, with some sulphate of potash	11
Oxide of iron	30
Sulphate of lime	12
Loss	15
	400

Another specimen, far more active or fertile, was found to give the following results:

	Parts.
Decomposed vegetable matter	110
Unaltered vegetable fibre	2
Fine silicious sand	156
Alumina	16
Silica (flint)	102
Soluble vegetable and saline matter	4
Oxide of iron	4
Muriate of lime	4
Loss	2
	400

The above two tables will afford the reader some idea of the general composition of "peats" as usually found in the United Kingdom. He will perceive that many elements are here present for the formation of the richest fertilisers when substances are added to it to decompose the tannic acid and other noxious substances usually held therein.

Lime, salt, farm-yard dung, &c., are the materials usually added to peat to form those composts of which the latter is entered as the principal ingredient. A valuable fertilising compound is made up of the following constituents:

Dry peat	50 bushels
Quicklime	25 „
Bone dust	10 „
Common salt	2 cwt.
Sulphate of magnesia	2 „
Sulphate of soda	1½ „
Coal tar	20 gallons

The substances should be thoroughly incorporated, formed into a heap, allowed to heat and ferment for about three weeks, then turned over and allowed to ferment again, when the compost is ready for application. When partially dried, peat is ofttimes employed to absorb the liquid manure of the farm-yard.

Collecting a quantity of peat into a heap and subjecting it to the process of charring is a method usually undertaken by many prominent agriculturists. The ashes formed are distributed as a top-dressing for grass lands and turnips, and have been proved to be very beneficial as a fertiliser. The farmers in Flanders use peat-ashes very extensively, especially as a top-dressing. Clovers are the principal crops on which these ashes are generally strewn. Upon examination "peat-ashes" have been found to be thus constituted:

	Parts.
Sulphate of lime	12
Sulphate and muriate of soda	6
Carbonate of lime	40
Oxide of iron	3
Loss	7

The celebrated "Dutch-ashes" are composed of

	Parts.
Silicious earth	32
Sulphate of lime	12
Sulphate and muriate of soda (Glauber salt and common salt)	6
Carbonate of lime	40
Oxide of iron	3
Loss	7
	100

Nineteen bushels of these ashes to the acre ensure abundant crops of red clover, saintfoin, and other grasses, &c.

Davy bestowed much attention on peat-ashes and their constituents. He found that many kinds of this substance owe much of their fertilising qualities to the presence of gypsum. The peat-ashes of the Wilts and Berkshire counties he discovered to hold a considerable portion of this ingredient. In the Newbury peat-ashes he found gypsum to constitute one-third to one-fourth of its whole composition, while the peat-ashes of Stockbridge in Hampshire he ascertained to contain a still greater proportion of this ingredient. Other peat-ashes, however, in the British Isles, he found, on examination, to hold no quantity of gypsum that could be announced as "beneficial."

It is asserted that peat-ashes, when used alone for turnips, at the rate of fifty bushels to the acre, have proved equal in efficacy to fifty carts of farm-yard manure; but this event, no doubt, owed much of its success to the peculiar quality of the land, and upon the kind of peat applied.

SECTION IX.

Rape Cake.

The rape cakes used for fertilising purposes are the refuse adhering masses of the rape or cole seed after the oil has been expressed.

In the Netherlands this substance is much used as a manure; but in this country its employment is somewhat limited. The Yorkshire, Norfolk, and Lincolnshire farmers are the chief consumers of this article; its high price being, no doubt, the chief cause why it is not more

generally employed. All, however, are agreed, that as a manure, its effects are most powerful and immediate. Containing, as it does, a large proportion of mucilage, a quantity of albuminous matter, and a small portion of oil, we thus discern that for such plants as turnips, &c., this substance is peculiarly adaptable.

When first its utility as a fertiliser was demonstrated half-a-ton per acre was the quantity recommended; but by pulverising the mass, five cwt. has been found sufficient. In the Lincoln and Norfolk counties, sixteen bushels per acre is the quantity usually distributed. The rape cake should be kept dry and used as recently made as possible. Though instances have occurred where the benefits of this manure have extended to two crops, still in general it can only be looked upon as being capable of benefiting the one crop to which it is applied.

Like all fertilisers of an oily nature, its efficacy is much more assured during a wet than a dry season; and on clayey and other moist soils, than on light lands. In some districts it is used without an admixture of any kind for turnips, and is supposed to be most economically applied when thrown into the soil at the same time as the seed. If used in the same manner for potatoes, it is apt to produce very large and luxuriant tops, with a deficiency, however, of tubers. It is judicious, therefore, when employed for this latter crop, to make it into a compost with other ingredients, and when so applied, the mixtures form a powerful manure. Mixed in the proportion of one ton of the cake to thirty tons of farmyard dung, the compound has produced effects most astonishing in their beneficial results.

One striking quality attached to this fertiliser is the fact that when pulverised and strewed over the surface of the land, it exterminates the *Gryllus talpa*, so detrimental to plants growing on wet soils; and it is computed that

by the same means, most insects injurious to vegetation may be eradicated; even to wire-worm this substance has proved exceedingly noxious. If ploughed in during the operation of wheat-sowing, the result will certainly be found the raising of a quick and vigorous crop. One gentlemen, who makes a single ton sufficient for five or even six acres, by pulverising the cake, pursues the plan of ploughing the substance in about five or six weeks previous to the period of sowing; his reason for following such a system being that by the time the seed is sown the manure is entirely dissolved in the ground, and thus the seed becomes acted upon by the fertiliser immediately upon its application to the soil. It is asserted that employed at a cost of 2*l.* to the acre, the produce has been an increase of ten bushels to the acre, besides giving one fifth more straw.

Commenting upon the economy of applying rape-cake by the drill instead of the usual mode of distributing it broadcast, an advocate of the first method writes: "The application of rapecake powder by the drill has never been so common as it ought to be, for it is not only a very powerful, but a very easily manageable fertiliser . . . . and easily attainable at all seasons of the year. There is no doubt of the advantage of feeding stock with this food, the manure they produce, when so fed being exceedingly rich. Many farmers, however, owing to the want of cattle, or an unwillingness to lay out the requisite money, in a long course of stall-feeding, are deterred from using oil-cake to the extent they would otherwise do. The use of the oil-cake powder conveys to the land all the enriching ingredients of this fertiliser at once, and to the exact extent the farmer requires; there is neither the waste, the risk, or the trouble of stall-feeding to be dreaded. The oil remaining in the cake certainly constitutes its most enriching proportion; the oil abounding in the sprouts is

an instance familiar to the former, and when this oil is imperfectly crushed out, the cake produced is found exceedingly enriching. A very small quantity of oil left by the crushers in the cake will produce very great results; even three gallons of train-oil . . . . has been found amply sufficient per acre, when mixed with earth and ashes, to produce a capital crop of turnips. It has been found (and this is another illustration of the value of the manure drill) that when rape-cake is drilled in with the turnip seed, three and a half hundredweight per acre is sufficient, but if it is applied broad cast, then double the quantity is required."

SECTION X.

Hemp, Poppy, Cotton, and Cocoa-nut Cakes.

These different species of cakes may be employed in much the same manner as rape (*vide* preceding section). Generally they contain about four to four and a half per cent. of nitrogen; ferment very easily; and stimulate the plant into a rapid growth.

SECTION XI.

Bran.

This substance—the skin of ground grain—is highly recommended as a fertiliser.

M. Saussure in analysing the ash of the bran of wheat, found one hundred parts to contain:

	Parts.
Earthy phosphates	46·5
Soluble salts	44·15
Silica...	0·5
Metallic oxides...	0·25
Loss	8·6
	100

Demonstrating upon the qualities of bran, as a manure, one eminent writer observes: "Drilled in with the turnip seed at the rate of five or six hundredweight an acre, at a cost of 1*l.* 2*s.* 6*d.*, this substance brought the plants rapidly forward, and gave one-third more in weight of bulbs than the other parts of the field which had been treated in the same way in every respect, except that no addition of bran had been made to them. If moistened with urine and slightly fermented, the action of bran would no doubt be hastened and rendered more powerful."

"The husk of the oat," continues the same author, "hitherto wasted at many of the oatmeal mills .... might also be beneficially fermented and employed as a manure."

SECTION XII.

Malt Dust.

Malt-dust—cummings or combings—is the dust or substance that separates from the malt whilst the sprouted seed is undergoing the process of "drying."

This material has been found very beneficial when applied to soils of a certain description. Some agriculturists assert that it has been proved to be almost equal to rape-dust in fertilising properties. Generally, one hundred bushels of barley produce about four or five of the dust.

If applied when in a dry state it decomposes but slowly; and it is a complaint with many farmers, that, owing to its extreme lightness, some difficulty is ofttimes experienced in its application. When used in this condition and harrowed in with the seed, about thirty bushels to the acre is the quantity usually employed—though for wheat some farmers distribute as much as forty bushels to each acre, and for barley or turnips about thirty-three or four bushels per acre.

For grass lands malt dust is eminently calculated, and if strewed at the rate of about thirty-three bushels to each acre, a considerable increase in the produce of the crop will almost invariably prove the result.

The dust is much improved by the admixture of liquid manure, and then laid in a heap for a few days until fermentation commences, when it may be either drilled in with the seed or spread over the surface of the ground. Some farmers place malt dust in the bottom of pigeon houses, or in such tanks as receive the urine from cattle. Mixed with the moisture from the dung-hill, or, in fact, with any liquid refuse adaptable for fertilising purposes, will be found a profitable course. When so incorporated it may be applied with good effect to either potatoes or turnips without the admixture of any other ingredient.

SECTION XIII.

Brewers' Grains.

When employed as a manure, this substance has proved most excellent in its effects; especially when distributed as a dressing for grass lands. Mr. Buckland, of Glamorganshire, in a letter to the editor of the *Mark Lane*

Express, thus gives his experience: "Having observed the marked luxuriance of the grass upon which some brewers' grains had been scattered, I was induced to manure several meadows with grains mixed with stable dung, and a few with grains only. The crop of hay is an extraordinary one off the land manured with the grains and stable dung together; but from the land manured with *grains alone*, the crop is prodigious. On one part of a deep declivity, where the ordinary produce has been about ten or twelve hundred weight of hay to the acre, and the quality very coarse, a good sprinkling of grain was strewed, leaving the other part of the same ground untouched. Where the grains were spread there was more than two tons of hay to the acre, and the grass of the finest quality; where no grains were applied the crop is as usual both as to quantity and quality.

"In addition to the abundance of the crop, is the advantage of its earliness. The grass was over-ripe, and might have been cut a week sooner. The neighbouring fields not so manured, were full three weeks later. This is a matter of no little importance in this part of the country, where the weather is generally dry about the end of May and beginning of June, when there is no grass fit to cut; and almost invariably wet about the end of June and beginning of July, when all the farmers are busy hay-making."

SECTION XIV.

Coal.

Hazenfrez was the first to discover that coal formed an essential constituent in the food of plants. Kirwan demonstrates that coal "though hitherto little attended to, appears to be one of the primeval principles, as ancient as

the present constitution of our globe; for it is formed in fixed air, of which it constitutes above one-fourth part, and fixed air exists in limestones, and other substances, which have their date from the origin of things."

Subjected to analysis, coal has been found to be composed as follows:

Volatile matter	62·25	=82·5
Charcoal	20·25	
Sulphate of lime	2·05	=17·5
Lime	2·	
Alumina	·05	
Sand	11·05	
Oxide of iron...	1·	
	100	

We are assured, on good authority, that "in the county of Durham the dust of common coal, such as is sifted out at the mines as too small for burning, has been spread upon poor, cold arable land, and as a top-dressing upon old pastures, with manifest advantage. Something will, no doubt, depend both upon the quality of the coal and upon the kind of land to which it is applied." Coal-shale is stated to have proved, in many instances, a beneficial manure, and no doubt would be found useful, especially upon light soils. In the Forest of Dean, oaks which were planted upon moulds around coal pits, "became the most vigorous of any in the forest, and were covered with healthy dark-green shining leaves."

When coal is burnt, the gaseous masses and much of the charcoal becomes dissipated, and the ash remaining generally contains carbon, sulphate of lime, silica, alumina, carbonate of lime, potash, and oxide of iron. In a few specimens examined magnesia, &c., have occasionally been discovered therein; but in the general species of coal ash, these last ingredients are usually absent.

Lucerne, saintfoin, red clover, &c., are enumerated

amongst the chief crops benefited by the employment of coal ashes. When liberally distributed as a top-dressing to these crops this substance has been found very advantageous. When so applied, the months of March or April will be found, generally, the best season. The fertiliser should be strewn at the rate of fifty bushels to the acre.

It may be observed that as sulphate of lime is found in very sensible quantities in turnips, and as it abounds also in coal ashes, we may therefore naturally conclude that whenever this ingredient is to be found in a sufficient proportion in any variety of coal ash, that ash will be found very beneficial for this crop, as also to peas, and potatoes, especially for crops growing on clayey lands, where this substance corrects the tenacity and opens the pores of the soil. When sprinkled half an inch in depth over the surface where peas and beans have been sown, these ashes hasten the germination of the seed, besides preserving the crop from the ravages of mice and other vermin.

In the neighbourhood of large towns these ashes afford an abundant source of manure. Around London—when distributed on those lands from which clay to form bricks has been dug—coal ashes have been employed with astonishing effects.

One gentleman demonstrating on the merits of coal ashes as a fertiliser, thus gives his experience: "I sowed," he observes, "on the 15th of May, three rows of Swedish turnips. No. 1 was manured with well-rotted dung; No. 2 with cabbage tops just coming into bloom; and No. 3 with coal ashes. They vegetated about the same time, but the row manured with the cabbage tops seemed to suffer most from the drought; the season being hot and dry, they made little progress until the end of August, and in November they were a middling, or bad crop. The row manured with coal ashes had, all along, a more luxuriant appearance than the other two. The rows were 20yds.

in length, 3ft. apart, and 15in. from plant to plant in the row. I took them up in February, and they weighed as follows: No. 1, 78lb.; No. 2, 88lb.; No. 3, 121lb.; which is very much in favour of the coal ashes."

SECTION XV.

Soot.

The volatilised unconsumed portion of common coal is familiar to us by the name of soot.

Upon analysis, 1000 parts of this substance has been ascertained to be thus composed:

	Parts.
Charcoal	371
Salts of ammonia	426
Salts of potash and soda	24
Silica	65
Alumina	31
Oxide of iron	50
Sulphate of lime...	31
Carbonate of magnesia	2
	1000

It is perceptible that all the components contained in soot are the natural food of plants; the carbon slowly combining with the oxygen of the atmosphere, becomes converted into carbonic acid gas, which the leaves and roots of the plants greedily absorb.

Through being such a powerful fertiliser many agriculturists are of opinion that soot ought to be used in a dry state; and likewise, should always be distributed as a top-dressing. Being extremely nauseous as it is to all vermin, it is supposed to be an exterminator, to a certain extent, of maggots, and even the wire worm. The cause of this is no doubt owing to the bitter extract which

soot contains. The farmers of Essex chiefly employ this fertiliser during the months of March, April, or May as a top-dressing to wheat, and when so applied at the rate of twelve to twenty bushels per acre, it is found to produce most luxuriant crops. When given as a top-dressing to grass lands it usually produces astonishing beneficial results; but many agriculturists declare that if strewed during the spring season, a peculiar bitterness is ofttimes given to the pasture; and it is further asserted that this taste is even imparted to the milk of the cows fed upon such grass. For this reason, we are assured, that cow keepers in large towns are sometimes unwilling to purchase those crops which have been top-dressed with soot.

One gentleman states that "wheat and oats dressed with soot, in comparison with undressed, gave the following return of grain.

	Wheat.	Oats.
Undressed	44 bushels	49 bushels
Dressed	54 „	55 „
Increase	10 „	6 „

"It acts also upon root crops—fifty-six bushels of soot mixed with six of common salt have produced larger crops of carrots than twenty-four tons of farm-yard manure, with twenty-four bushels of bones." On onions soot is constantly employed with equal benefit; and it is observed that where soot is sown, vermin scarcely ever appear.

Many farmers recommend its admixture with earth and lime in the proportions of one part soot, five parts earth, and one part lime; those who have applied this mixture inform me that it has always proved, without fail, of great benefit to the crop.

Demonstrating upon the still greater fertilising effects as produced by soot when applied in a liquid form, Mr. John Robertson, of Kilkenny, writes: "On meadows I

have used soot with much advantage in substance, and though sown by the hand, one dressing gave me always heavy crops of hay for two successive years. But this is a wasteful mode of applying it, a great portion of its ammonia, one of its most active ingredients, being volatilised and dissipated in the atmosphere; when dissolved in the water there is no waste, it is all available; and for horticultural purposes, I have mostly used it in that state, mixing it up in the proportion of about six quarts of soot to a hogshead of water." Asparagus, peas, and a variety of vegetables the same gentleman asserts he has experimented upon with this liquid, and has found it to be equally as efficacious as if he had used solid dung.

SECTION XVI.

Charcoal.

Charcoal, when well burnt, is almost pure carbon, the other portion being a minute proportion of hydrogen, and a small quantity of earthy matters.

"The reason of charcoal being so useful as a manure is very apparent. MM. Sennebier, Ruckert, Saussure, and others, have demonstrated that plants are rendered much more luxuriant and productive by having carbonic acid applied to their roots, than other plants to whose roots no such application was made. Now, charcoal, kept moist, as when buried in the soil, slowly combines with oxygen and emits carbonic acid; in fact it slowly dissolves. We are sorry to differ from such an authority as Liebig, who broadly asserts that 'carbon never combines, at common temperatures, with oxygen, so as to form carbonic acid.' This was long since shown to be otherwise by Count Rumford, and may easily be demonstrated to be incorrect

by confining a few ounces of fresh and moistened charcoal-powder, mixed with earth, in a glass receiver full of oxygen over lime-water; carbonate of lime will form, showing the gradual evolution of carbonic acid" (Editor: "The Gardener's Dictionary"). When pure, charcoal is an excellent application for curing unhealthy plants. It has been observed that this fertiliser has always produced the best effects when permitted to lie during the winter exposed to the action of the air. Discoursing upon charcoal, Mr. E. Lucas remarks: "The action of charcoal consists primarily in its preserving the parts of the plants with which it is in contact—whether they be roots, branches, leaves, or pieces of leaves—unchanged in their vital power for a long space of time, so that the plant obtains time to develope the organs which are necessary for its further support and propagation. There can scarcely be a doubt, also, that the charcoal undergoes decomposition; for after being used five to six years it becomes a coaly earth, and if this is the case, it must yield carbon, or carbonic oxide, abundantly to the plants growing in it, and thus afford the principal substance necessary for the nutrition of vegetables. In what other manner, indeed, could we explain the deep green colour and great luxuriance of the leaves of every part of the plants, which can be obtained in no other kind of soil, according to the opinion of men well qualified to judge? It exercises, likewise, a favourable influence, by decomposing and absorbing the matters excreted by the roots, so as to keep the soil free from the putrefying substances which are often the cause of the death of the *spongiolæ*. Its porosity, as well as the power which it possesses of absorbing water with rapidity, and after the saturation of allowing all other water to sink through it, are causes also of its favourable effects." Another writer reminds us that through the remarkable properties charcoal possesses of

absorbing noxious vapours from the atmosphere and soil, and "of extracting unpleasant impurities as well as saline substances from water, and of decomposing many saline compounds"—besides the power it has of sucking "into its pores much oxygen and other gases from the air"—through these and other qualities, charcoal "forms a valuable mixture with liquid manure, nightsoil, farmyard manure, ammoniacal liquor or other rich applications to the soil. It is even capable itself of yielding *slow* supplies of nourishment to living plants; and it is said in many cases, even when unmixed, to be used with advantage as a top-dressing in practical agriculture.* In moist charcoal the seeds of the gardener are found to sprout with remarkable quickness and certainty; but after they have sprouted, they do not continue to grow well in charcoal alone." It is asserted that when drilled in with the seed charcoal powder greatly promotes the growth of wheat.

* This may, no doubt, be in part owing to its aiding the production, as all *porous* substances do, of ammonia in its exterior, and hence of apocrenate of ammonia in the soil, but in part also to its power of decomposing other substances.

PART III.

ANIMAL MANURES.

Dead Animals — Fish — Blood — Animalised Charcoal—Bones — Horn — Woollen Rags, Hairs, Feathers, &c.—Nightsoil—Farmyard Dung—Guano.

In the list of animal manures are enumerated those species most generally employed by the British agriculturist—bones, nightsoil, farmyard manure, and guano, being included in this arrangement.

SECTION I.

Dead Animals.

Animal matters in general, act so powerfully as fertilisers, as not to require any chemical preparation to bring them into a state suitable for the purposes of manure. Generally, such substances can be utilised in the various manufactures; but when considered, however, fit for manure only, the agriculturist's chief object should be in seeing that such matters be blended with the various earthy substances in such a manner as to prevent their too rapid putrescence.

A learned writer remarks that "much of this species of manure is lost in many parts of the country from want of proper attention, or perhaps from ignorance of its value.

Animals that have died accidentally, or in consequence of disease, are often suffered to remain exposed to the air, or immersed in water, till they are destroyed by beasts of prey, or entirely decomposed by the action of the atmosphere; and in this case, most of their muscular substance is lost for the land in which they lie, and wasted in the production of noxious gases which pollute the surrounding air. By covering dead animals with five or six times their bulk of soil mixed with one part of lime, and suffering them to remain a few months, their decomposition, as Sir H. Davy remarks, would impregnate the land with soluble matters, so as to render it an excellent manure; and by mixing a little fresh quick lime with it, at the time of its removal, the disagreeable effluvia would be in a great measure destroyed, and it might be applied with much advantage to any of the stronger species of crops."

Everything upon which life has been bestowed may very justly be considered as suitable, more or less, for fertilising purposes; for the reason that all animal and vegetable matters alike are constituted of carbon, oxygen, hydrogen, and nitrogen with a small proportion of saline constituents: their individual characteristics may be endlessly at variance with each other, but to each kind is endowed the qualification of *enriching* the soil.

SECTION II.

Fish.

Fish, usually, such as herrings, sprats, pilchards, &c., all form most powerful manures. The reason of this is very obvious: the scales consist of coagulated albumen and phosphate of lime, the bones are full of oil and other soluble constituents, whilst the rest of the solid portion is

composed of phosphate of lime and carbonate of lime in different proportions.

Applied chiefly in the form of the refuse of the various fisheries, these fertilisers have been found to be "too strong" when applied directly to the land. Farmers, therefore, generally make up a compost of the substance with a large quantity of soil, in the proportions of five barrels of fish or fish refuse to about eighteen loads of soil—this quantity of the mixture being usually allowed to each acre.

The Herring.—The utilisation of this fish as a fertiliser must necessarily be confined to those districts where the shoals of herrings are frequent visitors. Respecting the results, as produced through the application of this fish, accounts both praising and condemning its use has been received. In one instance its employment produced a rank crop of wheat. In another district, where a field sown with the same cereal had been previously manured with these fish, the crop grew so luxuriantly as to be entirely "laid" ere attaining maturity. When applied to turnips, a distribution of spoiled herrings over the field at the rate of twenty-four barrels to the acre has been instrumental in producing very heavy crops. To the hop plantations also, it is demonstrated that an application of red herrings has been found of immense benefit. The farmers of Sweden consider the cake produced by the "herring-oil-makers" one of the most powerful of manures.

Sprats.—The use of this manure in the counties of Kent, Essex, Suffolk, and Norfolk is pretty general. Purchased at the rate of 6*d.* to 8*d.* per bushel, the fish are applied in quantities varying from twenty to forty-five bushels per acre, the poor gravelly lands requiring a larger application than the loamy soils. Employed upon oats this fertiliser has produced crops of "a peculiar dark

green colour, yielding ten to eleven quarters per acre, and that on land of a very second rate quality." Made up into a compost, with mould in the proportion of a ton or a ton and a half of the sprats to about fifteen hundredweight of mould, and this aggregated amount allowed to each imperial acre, such a mixture has been found very efficacious in its effects. These fish may be mixed even with common soil, in place of the mould, and if permitted to remain in a heap for some time ere subjected to distribution the fishy matters will dissolve; and when applied to turnips, whilst just at a state of dissolution, this compound has proved highly advantageous.

Pilchards.—In Cornwall and Devonshire this fish is extensively employed for manuring purposes, and the effects produced through their application have been declared to be most excellent.

Generally the farmers mix the pilchards with sea-sand, soil, or at times sea-weed; thus restraining the fish from causing too rank a growth. Sir H. Davy asserts that when employed as a fertiliser the effects of pilchards are obvious for several years.

Sticklebacks.—These little fish are found in such places as the Fens of Lincolnshire, Cambridgeshire, and Norfolk, and are caught in such quantities as to afford cheap manure for the agriculturists of the surrounding districts. In fertilising properties they possess much about the same virtues as sprats.

In Rhode Island and the adjoining states of North America a celebrated writer affirms that "considerable quantities of manure are made by mixing the fish called *menhaden*, of which large numbers are taken in the bays, with peat or swamp mud, in the proportion of one load of fish to ten of peat or mud. As many as 750 tons of this fish have been taken at a single haul, and sold to the farmers at about two shillings and sixpence the thousand

fish or waggon load. On the coasts of Connecticut large quantities of fish, called white fish, are caught and sold for manure at the rate of about a dollar (4*s*.) a thousand, weighing fifteen or twenty hundredweight. They are either laid on the land and ploughed in, or are made into a compost." "In the North of China," continues the same author, "prawns and other kinds of fish are collected and employed for manuring purposes."

The *Blubber of Whales* and other large sea-animals has produced most excellent crops. Such material possesses also the advantage of making its good effects upon the soil apparent for a succession of years; but its high price retards its general adoption.

Experiments have shown that when applied alone blubber is evidently too powerful; therefore, those agriculturists who employ this substance as a manure generally mix it with either mould, earth, sand, or clay. Twelve to twenty times its own weight of any one of these ingredients are the usual proportions. If the heap be allowed to ferment, and turned over occasionally whilst undergoing such a process, the blubber will become decomposed, and the mass now friable and possessing fertilising virtues of the most efficacious description may be applied either upon arable or pasture lands.

Shell-fish, when mixed with a little earth into a mass, and the same permitted to ferment, have been proved advantageous towards raising heavy crops of turnips and potatoes. One gentleman affirms that "on the northern shores of the Solway, near Annan, the common mussel is found in such quantities in some places, that, when the tide recedes, a cart-load can be raked out of the sand in so short a time as to make it a very convenient manure. The Rev. Mr. Gillespie, of Cummertrees, informs me, that 700 cart-loads were collected and applied to the raising of turnips during the year 1844. They are used without

other manure at the rate of about fifty bushels to the Scotch acre. On the coast of Lincolnshire also they are met with in some places in large quantities, and collected for use as a manure."

The shells of the oyster and lobster having been analysed, they were found to be composed of the following ingredients:

	Phosphate of Lime.	Carbonate of Lime.	Animal Matter.
Oyster	1·2	98·3	0·5
Lobster	7·	63·	30·

The above table reveals to us that for those soils deficient in calcareous matter these shells in a pounded form will be found advantageous to the crops growing upon such lands.

SECTION III.

Blood.

As this substance holds certain quantities of all the elementary constituents contained in other animal matters, we find it possessing great fertilising properties, though, like most animal matters, its effects are but transient.

The blood of the ox consists of about 80 per cent. of water and about 20 per cent. of solid matters. The latter when dried contains in every 100 parts—

Carbon	51·950
Hydrogen	7·165
Nitrogen	17·172
Oxygen	19·295
Ashes	4·418
	100·000

The ashes comprehend various salts, as phosphate of lime, chloride of sodium, with a little oxide of iron.

M. Berzelius found the serum of the blood of the bullock to contain in every 1000 parts the following components:

	Parts.
Water	905·000
Albumen	79·999
Lactate of soda and extractive matter	6·175
Muriate of soda and potash	2·556
Soda and animal matter	1·520
Loss	4·750
	1000·000

Mixed with earth, blood forms an excellent fertiliser. "In Northampton," writes one gentleman, "a compost is made by mixing about fifty gallons of blood with eight bushels of peat-ashes and charcoal-powder, and allowing the mixture to stand for a year or two. On light soils this compost raises excellent turnips when applied alone, at the rate of six quarters (forty-eight bushels) per imperial acre, or of two quarters with twelve tons of farmyard dung. As a top-dressing to young wheat twenty or thirty bushels an acre greatly increases the crop. On heavy and wet lands its effects are less perceptible. In that part of England the blood is contracted for at the rate of 3*d.* a gallon. In some countries the blood is dried, and in the state of powder is applied as a top-dressing to the growing crops. . . . . Samples prepared in London and containing still 22 per cent. of water have also been valued at 8*l.* or 9*l.* a ton."

Blood may be mixed with advantage with such refuse matters as "road-scrapings," sawdust, tanners' bark, &c. By such a procedure, the farmer employs a fertiliser *immediate* and lasting in its good effects upon the soil. With soot, a most powerful compost is formed. It is through blood acting *so immediately* and powerfully upon

vegetation, that we find it so ofttimes entered as an important ingredient in the compositions of the "artificial manure" manufacturers.

SECTION IV.

Animalised Charcoal.

The utilisation of this compound as a manure is limited to those districts in which the refining of sugar is carried on. Commenting upon this subject, an author remarks: "As blood comes from the sugar refineries—in which, with lime water and animal charcoal, it is employed for the refining of sugar—it has obtained a very extensive employment, especially in the south of France. This animal black, or *animalised charcoal*, as it is sometimes called, contains about 20 per cent. of blood, and has risen to such a price in France that the sugar refiners actually sell it for more than the unmixed blood and animal charcoal originally cost them. This has given rise to the manufacture of artificial mixtures of charcoal, fecal matters, and blood, which are also sold under the name of animalised charcoal. One great disadvantage attending the use of these artificial preparations is, that they are liable to be adulterated, or, for cheapness, prepared in a less efficient manner."

SECTION V.

Bones.

The bones of different animals vary in their composition, as also at various periods of the animal's life. As bones are dependent upon their supply from the blood, we consequently perceive that their fertilising qualities depend in

no small degree upon the animal itself: if the latter be badly kept, the constituents of its bones cannot be so rich as one that is well kept and in first-rate condition.

The following table illustrates the average composition of bone:

	Parts.
Ossein	33
Tricalcium phosphates	57
Calcium carbonate	8
Calcium fluoride	1
Magnesium phosphate	1
	100

M. Merat Guillot undertook the task of analysing the bones of different species of animals, the result of which he gives as follows:

Bones.	Phosphate of Lime.	Carbonate of Lime.	Animal Matter.
Horse	67·5	1·25	31·25
Calf	54·	—	46·
Sheep	70·	5·	25·
Hog	52·	1·	47·
Elk	90·	1·	9·
Hare	85·	1·	14·
Pullet	72·	1·5	26·5
Carp	45·	5·	50·
Pike	64·	1·	35·

The preponderance of phosphate of lime in the bones of the different animals supplies the main reason why bones constitutes such a valuable manure. As their effects, also, are most powerful when divided into as minute a division as possible, we at once discern the cause why "bone-dust" acts more immediately than those bones applied in larger

pieces. Many agriculturists are of opinion that bruised bones are rendered much more beneficial when mixed with ashes, or, in fact, with any other manure: their reason being that the juice of the bones, by such an incorporation, becomes much more equally distributed over the field. Respecting the ground most fitted to receive an application of this fertiliser, a dry, light or gentle soil is certainly the best adapted; it being supposed that wet lands "wash" the nutritive components of the bones to the surface, the result being that the fertiliser does not incorporate its constituents sufficiently with the soil. Still, even on heavy wet lands this manure has proved highly beneficial. To those soils usually denominated "poor" and "thin," a strewing of bone manure at the rate of twenty bushels to each acre, has been the means of causing crops of more than ordinary luxuriance to be the result.

As a fertiliser for turnips, bones are used with great advantage. One gentleman in Scotland, who experimented with this manure, gives his experience. He applied the substance over two acres at the rate of twenty-five bushels to each acre, whilst "on two adjoining acres," he observes, "I applied twenty-five cartloads per acre of well-made farmyard dung. The season at time of sowing was rather wet, and not very favourable for the first growth of turnips. Those with bones came above ground on the third day very dark-coloured and broad in the leaf. At this time I examined the state of the manure, and found it one mass of maggots; but two days after they were all dead; and the weather being now dry and warm, the most rapid vegetation I ever remarked took place; so that by the fifteenth day from the time of sowing, the turnips were fully strong for being thinned out. . . . The plants where the farmyard dung was applied did not come up till the fifth day, and the turnips were twenty days sown before they were fit for being thinned. By this time the bone

turnips were meeting on the top of the drill, and they continued to maintain the advantage of their first start until the month of September, which set in rather dry. At this time I anticipated that the bones would be exhausted and the dung crop growing; but such was not the case, for while the dung crop began to fade and stop growing, the bone turnip kept growing vigorously. At the middle of October, when I considered both crops at maturity, I had a comparative trial of their weight carefully made, the result of which was six tons per acre in favour of the bones—there being twenty-eight tons per acre of Aberdeen yellow turnip, and the farmyard dung only twenty-two tons per acre." When we perceive the nutriment afforded to the turnip while in a young and tender state, and the eagerness with which its roots entwine themselves around the fragments of the bone manure, we thus comprehend why bones form such an efficacious fertiliser for this bulb.

An enthusiastic in lauding the effects of bone dust upon the turnip crop has versified his sentiments in the following strain:

No bone dust, no turnips; no turnips, no wheat;
No wheat and no turnips, no cattle, no meat;
No turnips, no cattle nor manure in the yard,
Makes bills for the doctors, and farming goes hard.

When applied to white clover the phosphate of lime which predominates in the bones, enables the clover to strive more successfully than it otherwise could do, against the coarser grasses.

As a manure for the potato, bones have been employed with great success. Some agriculturists recommend the practice of burying in the bone-fertiliser about two months previous to the planting of the crop; by this system the manure, having become decomposed in the ground, acts upon the potato immediately the crop is planted. Many farmers practise the plan of making up the bones into a

compost with about five or six times their bulk of earth and well incorporating the whole. After allowing the mass to ferment for a few weeks the mixture is either buried in with the crop, or if for clover, distributed as a top-dressing.

"The practice is becoming every year more general of giving bones either raw or dissolved, along with guano and dung. The great crops of Hardgrave for several years brought this under notice; and the large weights of all sorts at Dalfibble, Shaw, and Barnsdale (the two latter at an elevation of 500 feet and second-rate quality of soil), ... may extend still more the practice of applying bones in both forms. One member [of the Agricultural Society of Ireland] showed, from a distinct set of experiments, in each of the last seven years, and on different varieties of soil, that dissolved bones, at the same expense, produced equal results in the turnip crop with guano, while the greater permanency of its effects on the succeeding crops is acknowledged. This report, by a class of as shrewd farmers and careful observers as can be found in any country, is very strong indeed. The conclusion come to by them, however, is quite in harmony with many experiments and reports upon the same subject. Meantime, it seems beyond a reasonable doubt, as regards green crops, that properly dissolved bones are equal to, and therefore a good substitute for, Peruvian guano, and not so expensive or difficult to be got. If, in addition, the nitrates be found to supply as advantageously the nitrogen or ammonia necessary for the green crops, the farmer's resources will be in no small degree bettered, and by combining phosphates with nitrates, the expense of the manure, may be ultimately reduced, without diminishing its practical efficacy or increasing its expense beyond that of guano. Glancing back, then, upon some of the leading elements of the general question, it is obvious that the economical manufacture of bone-dust, the dissolution of

the bone, the formation of soluble phosphates, and the cheapest and most effective method of applying such bone manure, are matters of the first consequence to the agriculturist. Peruvian guano at 13*l.* or 14*l.* per ton, will not do for farmers generally, and the nitrates being considerably higher in price per ton, it is obvious that their nitrogenous element will require to be cautiously drawn upon in the compounding of a manure, which must necessarily be composed of phosphates and alkalies:" (Harkness.)

To dissolve bones, and apply them in that state meets with much favour throughout the agricultural community. The process is very simple—100lb. of bone-dust are mixed with from 50lb. to 100lb. of diluted sulphuric acid, when, by stirring the compound occasionally, the bones will be found in a few days entirely dissolved or reduced. This solution may either be diluted with about fifty times its own bulk of water and applied as a liquid manure; or, it may be incorporated with fine soil, sawdust, or any other powdery substance adaptable for fertilising purposes.

Demonstrating upon the success of bones when reduced to such a condition, a gentleman of authority gives the following particulars:

"At Gordon Castle the following results were obtained:—

Manure per Imperial Acre.	Cost.	Produce of Bulbs. Dale's Hybrid.
	£ s. d.	
14 yards farmyard dung 8 bushels bones	3 0 0	12 tons.
3 cwt. guano	1 17 0	11¼ ,,
16 bushels bones...	1 16 0	11 ,,
2 bushels bones ... ... 83lb. sulphuric acid ... 400 gallons water... ...	0 11 6	12 ,,
8 bushels bones ... ... 83lb. sulphuric acid sown with the hand...	1 5 0	11 ,,

The largest produce was here obtained, when the dissolved

bones were applied by a water-cart, and at a cost of 11*s.* 6*d.* per acre.

"Again, on the farm of Sherifftown, in Morayshire, the following comparative results were obtained:—

1.—SWEDISH TURNIPS.

Manures.	Cost per Acre.	Produce in Bulbs per Imperial Acre.
73lb. (1½ bushels) bones, 46lb. acid, 400 gallons water	£ 0 9 3	17½ tons.
The same with 200 gallons water	0 8 3	18½ „
440lb. (9½ bushels) bones, 28lb. acid	1 4 9	17 „

2.—COMMON TURNIPS.

170lb. (3½ bushels) bones, 92lb. acid, 400 gallons water	0 17 6	16 tons.
16 bushels bones, 46lb. acid, 400 gallons water	2 2 0	13½ „

In all these cases the smaller quantity of bones, when dissolved in acid and applied in a liquid state, gave a heavier return of bulbs than the larger quantity when drilled in dry. Even the watering of the large quantity of bones with a portion of acid, did not make their effect on the crop equal to that of the small quantity of dissolved bones.

"Mr. Hannan obtained, by the use of crushed and dissolved bones upon turnips, the following results:—

Bones.	Tons.	Cwt.	
16 bushels, crushed, gave	10	3	per imperial acre.
2 „ dissolved „	9	12	„
2 „ „ „	11	15	„
4 „ „ „	12	11	„
4 „ „ „	14	6	„
4 „ „ „	14	11	„
8 „ „ „	13	15	„
8 „ „ „	15	2	„
8 „ „ „	16	1	„

We can explain this superior action of dissolved bones by the fact that the dissolving separates their particles completely from each other, diffuses them more completely through the soil, and presents them to a larger surface of the turnip roots, and in a state in which they can be more readily absorbed. The sulphuric acid also may have some effect, since we know that sulphur, in some form, is necessary to the growth of all our crops. I have, indeed, been informed of a case at Balcarres, in Fifeshire, where diluted sulphuric acid applied alone to the drills produced an excellent crop of turnips; and of another in Dumfriesshire, where steeping the seed-corn in diluted sulphuric acid added many bushels to the crop of barley.

"Though the immediate effect of a small quantity of bones on the first crop is made so much greater by this mode of applying them, it is not to be expected that the effect upon the after crops should be as beneficial as when a larger quantity of bones is applied in the ordinary method."

In bringing this subject to a conclusion, I would impress upon the practical agriculturist the fact that in "bones," he possesses a fertiliser, cheap, efficacious, and of lasting benefit to the land upon which it may be applied.

SECTION VI.

Horn.

This substance partakes of the chemical nature of the cartilaginous portion of bone, and is composed of—

Carbon	51·578
Hydrogen	6·712
Nitrogen	17·284
Oxygen } Sulphur }	24·426
	100·000

besides minute proportions of sulphate, muriate, and phosphate of potash, phosphate of lime, and other less important matters. Sir H. Davy reminds us that horn is a still more powerful fertiliser than bone, as it holds a larger quantity of decomposable animal substances. The farmers in the West of Scotland, we are informed, have ofttimes brought this material from Ireland for manuring purposes; though in general, horns are not sufficiently abundant to allow their utilization as a manure to become common.

The animal substances in the shavings of horn appear to be of the nature of coagulated albumen, and when placed in contact with water, become slowly soluble. The earthy principle in horn, as in bone, restrains the too speedy decomposition of the animal matter, and adds power to its qualities in benefiting the land.

In describing the virtues of horn *flints*, or *piths*, an eminent agricultural chemist states: "They" (horn flints, or piths) "resemble bones very much in composition. They contain a little more animal matter, and from their softness and porosity are more difficult to crush in the mill. For the same reason, however, they decay more rapidly in the soil, and act more immediately than bones. They boil down, however, more readily than bones, and are therefore largely used for making the size used in stiffening calicoes. For this purpose they are sold by the comb makers at about 4*l.* a ton. When they are not in demand for this purpose, they may be very usefully employed as a manure.

"A sample of the pith, as it is sold in the market, gave to Professor Morton in my laboratory"—

Water (lost at 212°)	10·31
Phosphate of lime and magnesia	46·14
Carbonate of lime	7·71
Gelatine (organic matter)	35·84
	100·00

In expounding the subject of horn-sawdust and hoof-parings, the same gentleman observes: "The small dust, parings, turnings, and shift of horn from the shops of comb makers, as well as the hoofs of cattle, are now sold to the prussiate of potash manufacturers at the rate of about 2*l.* a ton. If they were free from admixture, they should be worth to the farmer about the same price as woollen rags. They are usually mixed, however, with much sand and dust—amounting sometimes to 50 or 60 per cent. of their whole weight. In this state they are not worth more than two-fifths of the price of *dry* hair or woollen rags. They may be used instead of bones for the turnip or potato crop, but should be made into a fermented compost before they are employed as a top-dressing."

SECTION VII.

Woollen Rags, Hairs, Feathers, &c.

These depend for their efficacy on pretty much the same principle as the flesh and blood of animals. The chief difference being, that these are dry, while blood, flesh, &c., consist of about 80 per cent. of water. Therefore, we see that an application of wool, hair, &c., ought to enrich the ground as much as four or five times its own weight of blood, &c. Through being dry, however, wool or hair require a much long period to decompose than blood, &c.; and it is for this reason that where we find all soft animal substances to be immediate but transient in their effect; dry matters, such as woollen rags, feathers, &c., on the contrary, are much later in operating, but continue to make apparent their fertilising action upon the soil for a succession of years. The duration of their sustenance to the ground upon which they be applied, depends on the

soil itself. Upon heavy clays their effects are perceptible for two years; but on light chalky lands their beneficial actions are discernible for three or even four years.

Wool, when subjected to analysis, has been found to be thus constituted—

Carbon	50·653
Hydrogen	7·029
Nitrogen	17·710
Oxygen } Sulphur }	24·608
	100·000

When burnt, this substance leaves a very slight ash holding minute quantities of muriate of potash, and perhaps phosphate of lime.

Hair and feathers possess almost the identical components as wool.

The woollen rags, &c., are usually cut into very small pieces, through the medium of a chopper and block, and then either applied directly to the land at the rate of ten or twelve hundredweight per acre; or, made into a compost, and there left to ferment. In the hop districts they are buried at the roots of the hop plants with advantageous results. Also for wheat, turnips, &c., this fertiliser seems admirably adaptable. Many agriculturists are of opinion that as the matters slowly decompose in the soil, they sensibly apply warmth to the ground. The farmers of Berkshire and Oxfordshire, and also in the southern counties of England, appear to be the largest consumers of woollen rags, &c., for fertilising the land. The lightness of these substances, and cleanliness of employment, render them of peculiar service as a convenient manure; and another merit they possess, is that if it should be inconvenient for the farmer to employ them immediately, they will keep for any reasonable length of

time, providing they be kept dry. This is an important desideratum to many agriculturists, who ofttimes are prevented by uncontrollable circumstances from applying their fertilising matters at a date when, perhaps, each subsequent day means a diminution of the virtues of such manures.

The substance familiarly recognised as "shoddy"—which is the waste of the woollen and cloth mills of Yorkshire—is extensively employed by the agriculturists of Northampton, Kent, &c. This article is purchased at the rate of about 2*l.* a ton, and the farmers who utilise it, give accounts which lead us to sum up its properties as being pretty much the same as woollen rags, &c.

SECTION VIII.

Night-Soil.

"Night-soil," says a prominent writer on agricultural affairs, "has not been employed in this country to the same extent as on the Continent, although it is certainly one of the most valuable of the organic manures; and to this neglect many causes have contributed. Its disagreeable odour, certain vexatious fiscal regulations with regard to its removal, and erroneous modes of applying it either in excessive quantities, or mixed with other composts in such proportions that its powers could not be distinguished in the mass, its semifluid nature requiring for its removal carriages of a peculiar construction, the extent and completeness of the sewerage of our large cities, and several other minor obstacles, have rendered its use not nearly so extensive as, even in a national point of view, is desirable."

Human fæces usually contain the following ingredients:

	Parts.
Water	73·3
Vegetable and animal remains	7·0
Bile	0·9
Albumen	0·9
Peculiar and extracted matter	1·2
Salts (carbonate of soda, common salt, sulphate of soda, ammonia, phosphate of magnesia, and phosphate of lime)	2·7
Insoluble residue	14·0
	100·0

The following substances are generally found, according to M. Berzelius, in *human urine*:

	Parts.
Water	933·00
Urea	30·10
Uric acid	1·00
Mucus	·32
Lactic acid, free lactic of ammonia, and animal matters	17·14
Sulphate of potash	3·71
Sulphate of soda	3·16
Phosphate of soda	2·94
Phosphate of ammonia	1·65
Muriate of soda	4·45
Muriate of ammonia	1·50
Earthy matters	1·00
Silex	0·03
	1000·00

The valuable fertilising ingredients held in the *fæces and urine* of human beings, are made apparent by the above two illustrations; but like other animal manures, the properties of these substances must vary according to the quality, &c., of the food the people themselves consume.

As this "night-soil" contains much saline and soluble substances, and as it is compounded from the ingredients

of the food we consume, it therefore contains a great amount of those elementary matters which are requisite to all those plants on which we principally exist.

The relative value of night-soil, according to the experiments of M. Schubler and others, was found to be as follows: "If a given quantity of land sown without manure yields three times the seed employed, then the same quality of land will produce five times the quantity sown when manured with old herbage, putrid grass or leaves, &c.; seven times with cow dung; nine times with pigeon's dung; ten times with horse dung; twelve times with human urine; twelve times with goat's dung; twelve times with sheep's dung; and fourteen times with human manure or bullock's blood. But if the land be of such a quality as to produce without manure five times the sown quantity, then the horse dung will yield fourteen, and human manure nineteen and two-thirds the sown quantity."

Attempts without number have been made to render night-soil applicable in a dry state, devoid of unpleasant odour, and yet retaining its fertilising virtues in as great a degree as when in a fresh condition. Positively, however, all such efforts have more or less failed to produce the desired effect.

Adverting to several of these methods, a gentleman of authority upon the subject remarks: "Various modes have at different times been suggested by which night-soil might be rendered more concentrated and more portable. Simply drying it has been attempted with some success; but though by this means about 70 per cent. of water is driven off, yet, at the same time, a considerable portion of ammoniacal and other gaseous matters are evaporated: thus the manure is impoverished, while the stench of the operation is intolerable. Then again, it has been mixed with lime, in the way recommended by Davy; but judging by my own experiments, and those of my neighbours, I

am fully persuaded that this is not the most economical way of using night-soil. The lime certainly dissolves and partially decomposes it, but the fertilising effect of a given weight of night-soil mixed with lime is not nearly so great as when a similar weight of it is used either by itself, or mixed with some merely drying odour-absorbing substance. There are several of these kinds made." . . . Each preparation is on much the same principle, "it combines, and successfully too, the great object of driving off the water of the urine and night-soil by a gentle heat, after all its gaseous matters have been absorbed, by mixing with it a portion of newly prepared carbon in the minutest state of division, than which no known substance has such great powers of absorption of all gaseous matters like those which abound in and impart the disagreeable odour to night-soil. These purifying powers of charcoal have been long known: the medical man applies it in putrescent cases, the housewife rubs it powdered over her tainted meat, and the sailor chars the inside of his water-casks for a similar purpose. The presence of the carbon in the manure thus prepared is valuable in two ways: it gradually combines with the oxygen of the atmosphere, forming in the state of carbonic acid gas the food of plants; and, at the same time, all the gaseous matters of putrefaction with which it is saturated are thus preserved, stored up, as it were, for the service of the roots of the cultivator's crops; nothing is lost, the emission of the gases from the slowly dissolving charcoal being so gradual, as to be almost, if not entirely, imperceptible to the senses.

"Such, then, are the principal facts already ascertained with regard to the fertilising uses of night soil, and other decomposing manures, in their ordinary form, and when reduced by various processes to such a state of dryness, as to be easily applied in the state of powder to the soil by the drill."

In many Continental cities the night soil is first dried in the air, with or without a mixture of gypsum or lime, then slightly desiccated upon "drying plates," and ultimately in "stoves," from which the substance is placed in casks, and sold under the name of "poudrette."

The Chinese knead the night-soil into cakes with a certain kind of "fat" clay, dry the mixture in the air, and sell the composition under the name of "taffo."

The Persians simply to allow it become dried by the sun, and then powder it.

But as yet no system appears to answer the purposes of the British farmer so *cheaply* and so well as that of mixing with the night-soil a suitable proportion of half-dried peat, sawdust, or even rich vegetable mould *previously* incorporated with a *preponderating proportion of gypsum.*

SECTION IX.

Farmyard Manure.

It cannot but be admitted that even during this enlightened age much ignorance or neglect prevails in the preparation and management of this, one of the most essential of all fertilisers, for the consideration of the agriculturist.

The first smell which greets us on approaching a farm is the odour from the dung-heap. Often the yards appear to be purposely placed on a declivity to lose the benefit of the manure-liquids, and to keep the straw as dry as possible. The dung from the stables and houses is generally thrown carelessly into a heap, and there its most valuable gases are permitted to volatilise in the surrounding atmosphere until the heap decomposes to nearly half,

with useless rottenness in the interior, and an exterior no better than dry straw.

The same inconsistency prevails in the further management of this substance. When the heap in the yard accumulates to such an extent as to necessitate its removal, it is carted away to the field upon which it will be ultimately employed. There it is made into another mass until required for use; by this disturbance the same process of volatilisation goes on here afresh, until the matter has lost about three-fourths of its nitrogenous properties. And, as though the farmers desire especially to rid the fertiliser of its most valuable constituent "ammonia," when broken into again for final distribution, it is laid in small heaps all over the field, and there this valuable gas is permitted to escape afresh for a day or two—sometimes for a longer period—until at length the manure benefits the land in about the same degree as *rotten straw!*

Now, common sense tells us that great loss is here sustained through a deficiency of original arrangement and subsequent attention. *The dung-pit should be sunk at least three feet below the surrounding ground, and so securely formed that all liquid matters may be prevented from escaping. Then we receive all* the beneficial ingredients of the dung. *Further, it should be remembered that the more the gases escape in the surrounding air the less fertilising qualities will the heap possess.*

To prevent the "escape" of these "gases" various remedies are at hand, the simplest being the covering of the matter with soil. Better still are peat, gypsum, &c. A pound of common green copperas dissolved in a gallon of water, and the heap sprinkled over with the solution, has been found highly beneficial in preventing evaporation.

The constituents comprising the dung of the various

animals may here very justly claim our attention; by this means the reader will be able to discern the *respective* value of each animal's manure.

M. Zierl found by analysis in 1000 parts of the solid excrements of a horse fed on hay, oats, and straw, the following components:

	Parts.
Water...	698
Picromel and salts	20
Green matter, albumen, mucus, &c.	63
Bilious and extractive matter...	17
Vegetable fibre and remains of food	202
	1000

Upon being burnt these yielded the same chemist sixty parts by weight of ashes, which were composed as follows:

	Parts.
Carbonate, sulphate, and muriate of soda	5
Carbonate and phosphate of lime	9
Silica	46
	60

The urine of the horse contains, according to the analysis of MM. Foureroy and Vauquelin, in 1000 parts:

	Parts.
Carbonate of lime	11
Carbonate of soda	9
Benzoate of soda	24
Muriate of potash	9
Urea	7
Water and mucilage...	940
	1000

The fæces of cattle fed chiefly on turnips, when evaporated to dryness and then burnt, produced an ash which held the following ingredients:

	Parts.
Lime	12·
Phosphate of lime	12·5
Magnesia	2·
Iron	5·
Alumina, with some magnesia	14·
Silica	52·
Muriate and sulphate of potash	1·2

The urine of the cow in general is composed of—

	Parts.
Water	66
Phosphate of lime	3
Chloride of potassium and sal ammoniac...	15
Sulphate of potash	6
Carbonate of potash and carbonate of ammonia ...	4
Urea	4

The urine of cattle, after being allowed to putrefy for a month, was found by Dr. Sprengel to hold the following substances :

			Parts by Weight.
Water			95·442
Mucus			·04
Urea and resinous matter			1·
Benzoic acid,	Combined with potash, soda, and ammonia, forming salts,	... ...	·25
Lactic acid,		... ...	·5
Acetic acid,		... ...	·001
Carbonic acid,		... ...	·165
Ammonia, partly uncombined			·487
Potash			·664
Soda			·554
Sulphuric acid			·338
Phosphoric acid			·026
Chlorine			·272
Lime			·002
Magnesia			·022
Sulphuretted hydrogen			·001
Silica			·005
Oxide of iron			·001
Sediment (phosphate and carbonate of lime, and magnesia, alumina, &c.)			·18

M. Zierl examined the excrements of sheep fed on hay,

and upon burning 1000 parts by weight, he obtained 96lb. of ashes, which consisted of—

	Parts.
Carbonate and phosphate of lime	20
Carbonate, sulphate, and muriate of soda	16
Silica	60
	96

The urine of sheep, kept at grass, upon analysis was found to contain—

	Parts.
Water	96·
Urea	2·8
Salts of potash, soda, lime, magnesia, &c.	1·2
	100·

The urine of the pig, analysed by Dr. Sprengel, consisted of—

	Parts.
Water	92·6
Urea, mucus, albumen, &c.	5·64
Common salt, muriate of potash, gypsum, chalk, and Glauber's salts	1·76
	100·

The dung of fowls and pigeons contain much ammonia and phosphate of lime, mixed with decomposing organic matters and uric acid.

The reader will discern by the above illustrations, what valuable ingredients the excrements and urine of our domesticated animals furnish; and also, the highly fertilising compounds that are absolutely wasted through not saving the liquid manures. Passing through such depressed times as the agricultural community of the British Isles are at the present moment, it behoves us all to scheme how we can obtain manures possessing the highest fertilising virtues at the least possible cost; and

to assist us, nature silently points to such matters as these —the liquid substances of our farms—which, with few exceptions, are permitted to flow away unutilised. The agriculturist has such affairs as these in his own hands, so long as he will pay such exorbitant prices for "artificial" fertilisers, and pass by such valuable manures as these, he can only blame himself if he finds the profits of his labour dwindled down—through the expense incurred in the purchase of these artificial compounds—into a mere nominal sum.

The quality of the different kinds of farmyard dung must naturally vary according to the class of food given to the animal stock. Thus, the manure from the beast fed on oil-cake, corn, &c., holds far richer fertilising ingredients than that from the cattle of the strawyard. The same effect being of course visible in the stable; the dung from the horses fed on corn, &c., being much more powerful than from those subsisting on hay and straw. This difference in fertilising properties of the richest and poorest farmyard dung is much greater than is usually anticipated by many agriculturists. In some instances this disparity amounts to one-half—that is, *it takes two tons of the dung from the poorer fed animals to equal in fertilising virtues one ton from the well-fed stock.* Such a comparison is well worthy of the attention of the economical farmer.

Much diversity of opinion appears to prevail as to whether the greatest advantages are obtained through employing manure while in a "fresh" or "decomposed" state. "The relative advantages and disadvantages of applying farmyard manure in a fresh or highly decomposed state are very numerous. In the first place, farmyard manure on decomposing gives off its most valuable constituents in the form of ammonia, and necessarily, therefore, a great amount of its fertilising substances is

lost; but still, taking a given weight of fresh and highly fermented manure, the ammonia, pound for pound, in the latter is much greater, showing that the loss of ammonia is not in equal ratio to the loss in bulk. The following shows—

Fresh manure...	...	**100 cwt. contain**		**40 lb. ammonia.**	
After a time	... ...	**80**	„	**35**	„
„	... ...	**60**	„	**30**	„
„	... ...	**40**	„	**20**	„

Showing that while in fresh manure one hundredweight contains forty pounds of ammonia, *i.e.*, less than half, forty hundredweight of highly fermented contain quite half that weight of ammonia; and therefore, a pound of fresh is not worth so much as a pound of highly fermented by some considerable amount. Though fermentation results in the dissipation of ammonia, yet under certain circumstances the highly fermented is much more valuable, as in cases where the immediate action is required; and thus the manure in a certain stage of fermentation imparts its action at once to the crop. Yet, on the other hand, when winter manuring is carried out, the application of fresh manure is more advantageous, as the parts which are dissipated are greatly kept in the soil, particularly in the case of clay soils. It follows that a medium is far the best for ordinary purposes; thus it is far from judicious to let manure ferment till it has lost all heat, and then cart it with a view of its imparting an immediate action; good fresh manure is better even for immediate action than rotten manure, which has lost the most of its fertilising constituents, and is quite cold: (Essay written at Sessional Examination, Royal Agricultural College.)" There can be no doubt that the soil itself, and the period of distribution must necessarily to a great extent determine the solution as to whether decomposed or undecomposed manure should be employed. For instance, when dung is applied

to fallows during the months of July or August, preparatory to the sowing of wheat, a much less degree of decomposition will suffice than for such crops as turnips, &c. An argillaceous soil—"on which alone fallows should be resorted to"—does not require the dung to be so much decomposed as a finely pulverised turnip soil; and, besides, another consideration of some little importance should be borne in mind, viz., that such crops as turnips, carrots, and all plants which are very tender while in a young state, require to be pushed forward into as early a luxuriant growth as possible, decomposed dung, therefore, necessarily seems the best adapted for them. On the other hand, such crops as wheat appear to be more beneficially assisted by manure fresh from the heap; wheat, for instance, when sown, remains almost stationary, as it were, until the commencement of spring. Consequently, it is at the begining of this season that we desire the fertiliser to act; and here the superior action of the undecomposed or "fresh" dung, brings its efficacious qualities prominently forward. Decomposing but slowly, its effects are prolonged to such a date as to afford the crop much nutriment for a long time subsequent to its sowing. Whereas, by an application of decomposed manure, through being immediate in its action, its effect would be exhausted before the spring growth commenced, thereby requiring a top-dressing of other stimulating compounds to further benefit the crop.

The following is a summary of a few general rules to be observed relative to the application of farmyard dung:—

First, to remember that undecomposed manure has a tendency to lighten the soil, and further, its action is not so immediate as the decomposed, but more durable in its effects;

Secondly, rotten dung is considered to give solidity to the land;

Thirdly, to dilute liquid manure from a manure-heap with water previous to its employment, as otherwise, from the amount of ammonia it contains, it is apt to "burn" the vegetation;

Fourthly, to cover and surround dung-heaps with either earth, peat, gypsum, &c., during fermentation, and thus prevent the nutritive gases from escaping;

Fifthly, to remember that the dung of horses, pigs, and poultry is hot and adapted to a firm soil; whilst the manure of cows and all animals that chew the cud is cold, and therefore adaptable for light land;

Sixthly and lastly, to remember that all dung when well decomposed becomes of a cold nature, and for this reason should be utilised accordingly.

Adverting to the relative quantities of nitrogen contained in other manures, both in a moist and dry state, when compared to this fertiliser, the following table constructed from the experiments of MM. Pagen and Boussingault, exhibiting the amount of loads required of the respective sorts to equal 100 loads of farmyard dung "so far as the quantity of nitrogen they contain is concerned" will prove most interesting to the practical agriculturist:

	Moist.	Dry.
Pea straw	22	100
Sainfoin straw	83	361
Vetch straw...	39	174
Wheat straw	166	650
„	81	367
„ lower joints	97	453
„ upper joints with the heads, after thrashing	30	137
Rye straw	235	975
„ of 1841	95	390
Oat straw	142	541
Barley straw	173	750
Wheat straw	47	207
Jerusalem artichoke straw...	108	453

	Moist.	Dry.
Broom	32	142
Green beet leaves	80	43
Potato leaves	72	84
Carrot leaves	47	66
Heath leaves	22	102
Sea wrack	46	138
,, ...	42	123
,, ...	28	85
,, fresh from the sea	74	—
Malt dust	8	39
Buried clover roots	24	110
Flax cake	7	32
Rape cake	8	35
Fish cake	74	332
Grease cake...	11	49
Beet root pulp	35	154
,, ...	105	154
Potato pulp	76	100
Starch water	—	573
,, ...	—	645
Starch refuse	111	107
,, ...	24	—
Dunghill drainings	67	126
Sawdust of acacia	137	513
,, ...	173	629
Sawdust of oak	74	256
Solid cow dung	125	84
Cow urine	90	51
Mixed cow dung	97	75
Solid horse dung...	72	88
Horse urine...	15	15
Mixed horse dung	54	64
,, sheep dung	36	65
,, pig dung	63	57
,, goat dung...	18	49
Pigeon dung	4	21
Liquid Flemish manure	210	—
,, ...	181	—
Belloni's poudrette	10	44
Oyster shells	125	487
Marl	78	—
Dry muscular flesh	3	13

	Moist.	Dry.
Cod salted	5	17
,, pressed and salted	2	10
Blood, soluble	3	12
,, liquid	13	—
,, ,, ...	14	—
,, coagulated and pressed...	8	11
,, dry insoluble	2	11
Feathers	2	10
Cow's hair	2	12
Woollen rags	2	9
Horse raspings	2	12
Cockchafers...	12	14
Bones, boiled	5	25
,, moist	7	—
,, fat	6	—
Glue refuse	75	213
Glue dross	10	34
Graves	3	15
Animal blocking of the maker...	37	95
Animalised black	36	98
Noir de Champs	32	65

SECTION X.

GUANO.*

GUANO is the excrement of semi-aquatic birds.

This definition is now generally accepted by all classes.

* * * * *

The virtues of a specimen of guano are dependent upon certain properties which may be classified into three points, viz., 1, the relative amount of ammonia and quantity of organic matter; 2, the amount of phosphates present in it; and 3, the quantity of potash, soda, and other salts. Of these three essential properties the first, of course, is the

* Abridged from "Guano: its origin, history, and virtues" (by the author); vide the *Field*, Nov. 15, 1879.

most valuable, or in other words, would put the farmer to the most expense by purchasing it in a separate state.

The following table by Voelcker represents the constituents of natural guano, as obtained from its native bed:—

Urate of ammonia	9·0
Oxalate of ammonia	10·6
Oxalate of lime	7·0
Phosphate of ammonia	6·0
Phosphate of ammonia and magnesia	2·6
Sulphate of potash	5·5
Sulphate of soda	3·8
Muriate of ammonia	4·2
Phosphate of lime	14·3
Clay and sand	4·7
Undetermined organic matter, one-eighth of which is soluble in water, and water with traces of soluble salts of iron	32·3
	100

The above analysis enables us to perceive how much ammonia and phosphoric acid enter into genuine samples of guano. It is mainly upon these ingredients that its fertilising powers depend. There is, however, one deficiency the reader will have noticed in the above table, and that is the small amount of potash held therein. It is one of the valuable properties of guano that it contains a mixture of so many of these substances upon which vegetation flourishes, but of this salt, as just mentioned, it is manifestly deficient. Hence, for this reason, the admixture of wood-ashes, or any other beneficial substance abounding in potash, is advisable, whenever guano is about to be applied to the land.

To elucidate the reason more strongly, let us see what constitutes the ash of plants; for it is only by such an examination that we attain a sound practical knowledge of what manures are requisite to ensure fine crops. Take

those plants of most interest to the farmer, that is, characterised as forming the foods generally essential to the health of man. 1000lb. of the ash of the *grain* of wheat, oats, barley, and rye, the seed of beans, the tubers of the potato, and the bulb of turnips, contain respectively:

	Wheat. lb.	Oats. lb.	Barley. lb.	Rye. lb.	Beans. lb.	Potato. lb.	Turnip. lb.
Potash	237	262	136	220	336	557	419
Soda	91	—	81	116	106	19	51
Lime	28	60	26	49	58	20	136
Magnesia	120	100	75	103	80	53	53
Oxide of iron ...	7	4	15	13	6	5	13
Phosphoric acid ...	500	438	390	495	380	126	76
Sulphuric acid ...	3	105	1	9	10	136	136
Silica	12	27	273	4	12	42	79
Chlorine	—	3	trace	—	7	42	36
	998	999	997	1009	995	1000	999

1000lb. of the ash of the *straw* of wheat, oats, barley, and rye, contain respectively:

	Wheat. lb.	Oats. lb.	Barley. lb.	Rye. lb.
Potash	125	191	92	173
Soda	2	97	3	3
Lime	67	81	85	90
Magnesia	39	38	50	24
Oxide of iron ...	13	18	10	14
Phosphoric acid...	31	26	31	38
Sulphuric acid ...	58	33	10	8
Silica	654	484	676	645
Chlorine	11	32	6	5
	1000	1000	963	1000

We have but to glance at the above two tables to perceive how important an ingredient is potash in the ash of those plants enumerated therein; and of that constituent guano is sadly deficient.

Now if potash already exists in a certain soil, and if guano be applied to that land, we at once perceive that

the vacancy of this alkali in the manure is immediately supplied by the potash which the land contains; therefore now possessing every fertilising property in a high degree, its efficaciousness becomes a certainty. If, however, the soil itself be deficient in this substance, the crops for a surety—if manured with guano alone—will be unremunerative; cereals deficient in grain, all stem with ears alarmingly light; potatoes all haulm, with insignificant tubers; beans all stalk and no seed; and turnips, all tops and no bulbs; in other words, just the reverse to what the farmer desires. . . . The intellectual farmer who sustains much faith in guano as a manure, by the observance of the above few facts, may save much expense and labour, ere he commences to apply guano indiscriminately —as even now a daily occurrence—to *every* variety of land, irrespective of the organic or inorganic, or both, substances already held therein. To illustrate this fact, I give one of the many instances constantly occurring. A certain farmer in the neighbourhood applied guano to his crops, with the result of being rewarded tenfold for his labours. His agricultural neighbour being informed of his success, determines upon applying the same manure to his own crops. Accordingly the next season he does so. Upon his own land, however, the guano evidently exercises an injurious effect; for, instead of his wheat being so many bushels above the average, his potatoes and turnips so many tons, they are altogether the reverse, whilst his neighbour again reaps enormous crops. Unacquainted with chemistry, he is completely at a loss to account for this (to him) strange event, especially as he is assured (in his own mode of thinking) that his own soil is exactly of the same nature as his neighbour's.

Now, if that man had possessed a knowledge of agricultural chemistry in its analytical department, by an analysis of the soil previous to the application of guano

he would have discovered that his land was deficient in that valuable grain-constituent potash. The applied guano was likewise defective in that alkali. We thus immediately arrive at the reason of the failure of his crops, and their non-forming of ears, tubers, and bulbs respectively. The cause of the success of his neighbour's crops when the soil was subjected to the same examination, would likewise have been ascertained, as that land on the contrary, already held an abundance of potash, so that its deficiency in the applied guano was supplied from the soil itself. From the above exemplifications we can comprehend why it is that, whereas upon the one side we hear guano extolled as being certainly the most efficacious manure extant, upon the other we receive information of its non-success, and perhaps decided injuriousness upon the affected crops.

From experiments and natural inferences, grass crops would seem to derive the greatest benefit by the application of guano, and to exhibit the most wholesome and productive results of any crop acted upon ; whilst turnips and potatoes, on the contrary, show to the least advantage, Therefore, we may safely aver that the farmer unacquainted with chemistry in its agricultural analytical department may generally with confidence, and without fear of failure, apply guano to his grass lands ; whilst, on the other hand, with his cereals, leguminous, or bulbous crops, it is always advisable to administer the manure well mixed with wood ashes, or any other beneficial substance abounding with potash. Even where an admixture of potash is not requisite, it is always of benefit to mix with the guano four times its quantity of either finely sifted earth (moderately dry), sawdust, clay (slightly burnt), charred turf, or coal ashes, whichever of these substances is most conveniently at hand. By such a course several advantageous objects are attained, prominent amongst which are—first,

a partial disinfection of the guano by diminishing its smell and absorbing its volatile products; secondly, a separation of its active particles whereby their action on each other becomes diminished; and thirdly, presenting it to warm soils in a form in which its action will be less violent at the commencement, but more protracted and steady when given in an unmixed state.

Sometimes sand is mixed with the guano, and when for application upon cold clayey land, this is quite applicable; but when such a composition is made, the sand need not be given in more than double the quantity of the guano, and it should be applied to the soil soon after mixing; whereas any of the others may with advantage be allowed to remain unapplied (providing it be in shelter) for a week or more. And let it be carefully noted that the colder the land, when applying the mixture, the more slightly should the manure be covered, and conversely.

Perhaps it may not be generally known that common salt is a useful addition to guano. As it must ever be the object of the farmer to economise the use of the latter valuable and expensive manure, the admixture of salt with it cannot be too strongly recommended. By such a prudent course the former not only makes the manure go "much further," but prevents the escape of the most valuable ingredient in the guano, viz., ammonia. The kind of salt which is best adapted for mixing with the guano is the refuse article of the fish-curers, though the brine of any other salted commodity is almost equally applicable.

"Are the properties of guano exhausted upon the first crop, or do they extend to the second also?" This question is of great importance to the economical farmer. That its beneficial action, to a certain degree, extends to the second crop experiments have proved. For though the ammoniacal salts in their action may be more or less exhausted in a single season, yet the phosphates and other

saline substances still continue to benefit the succeeding crop. But the quality of the guano itself must, to a certain extent, determine this solution.

As being an extirpator of that pest, the "wire worm" guano has also in many cases been recommended. But, though no doubt distasteful to these insects, still its efficaciousness in that respect is not to be depended upon. Though in justice to this fertiliser it must be explained that at present, as generally applied for that purpose, the farmer, by its use, does not incur so great a risk as he does by the application of various nostrums conspicuously brought before his notice, as these are often compounded from ingredients more injurious to the crop and land than to the pests themselves.

Many artificial compositions have been manufactured as substitutes for "natural" guano, and, though perhaps not always so effectual as the true article itself, still in many instances the result of such applications have proved highly remunerative to the enterprising agriculturist. The following is Professor Johnston's substitute for guano:

Bone dust	7 bushels
Sulphate of ammonia	100lb.
Wood ashes	20lb.
Salt	100lb.
Dry sulphate of soda	11lb.

This composition will be found to be quite applicable as a general substitute for the original article. Another cheap and good artificial compost is:

	lb.
Bone dust...	315
Sulphate of ammonia	100
Pearl ash 20lb., or wood ashes	80
Common salt	80
Dry sulphate of soda	20
Nitrate of soda	25
Crude sulphate of magnesia	50
	670

It will be perceived that this is very similar to the preceding, with the addition of the nitrate of soda and crude sulphate of magnesia. Whether such an addition will be beneficial will depend, of course, upon the nature of the soil to be acted upon. Our American contemporaries, however, in the march of agricultural advancement have not permitted us to outstride them in this primary art; for their artificial compositions of guano will most certainly bear comparison as being equal, if not superior to those of our own origination. The following is one of their recipes:

	lb.
Bone ash, or ground bones	15
Carbonate of ammonia	10
Phosphate of soda	10
Sulphate of potash	5
Sulphate of soda	3
Sulphate of magnesia	6
Muriate of ammonia	5
Nitrate of soda	5
Nitrate of potash	2
Humate of potash*	20
Apocrenate of ammonia, &c.†	10
Oxide of manganese	5
Bog-iron ore, in powder	2
Fine silex from peat bog	2
	100

The only obstacle to restrain the last recipe from receiving favour at the hands of the agriculturist must be the expensiveness of some ingredients enumerated therein. But it must be remembered that 1cwt. of this substance applied to an acre of land would be found in the end to have been more efficacious than triple the quantity of

* Sawdust and potash melted together in an iron pot.

† Peat steeped in carbonate of ammonia, strained, and evaporated to paste.

many of the compositions sold at prices ranging from 9*l.* to 12*l.* per ton. Such facts as these should be readily borne in mind, for it is not the cheapest priced manures that are the most profitable to the farmer. As now generally admitted by all practical men, the cheaper the price asked for the manure, the less fertilising ingredients it will be found to contain. Therefore the agriculturist should be upon his guard ere he purchases those "low-priced manures" which infest the country to so great an extent.

That the buyer may be still more wary when purchasing guano, I give a few facts out of the many that have been exposed from time to time respecting this fertiliser and its extensive adulterations. In one district where so-called guano was being sold, an examination of the article proved it to be no guano at all, but a mixture of almost useless ingredients, so ingeniously compounded together that to the eye and smell it was undistinguishable from the ordinary substance. Another specimen was found to contain more than half its weight of gypsum, the rest being peat or coal ashes, with a small amount of common salt, and still less of sulphate of ammonia, and either dried urine or the refuse of the glue manufacturers to give it a smell. In another district, out of six samples examined, but two turned out to be genuine. "One of the specimens was sold at the rate of 13*l.* per ton, but it was only value for about 3*l.* per ton;" another that contained 54 per cent. of adulteration was pronounced by the analyst as being "the very perfection of adulteration," and "neither by colour nor yet by smell could its spurious composition be detected." From such ingredients as loam, breccia, turf ashes, and salt, hundredweights of the genuine articles have been converted into tons of the spurious substance, all so artfully compounded that only the scientific farmer can depend upon saving himself from

imposition. Many persons have been under the impression that, by obtaining it direct from the vessel, they are certain of procuring the genuine article. But even here they are duped, for ship after ship have been sent out to the guano deposits *ballasted* with gypsum. Further comments are needless.

To further assist the purchaser, I cannot do better than end this subject by placing before his notice the advice of two able writers upon choosing and analysing, by simple methods, any sample of guano placed before them. "In selecting a good guano," says the first writer, "the following simple observations will aid the practical man: (1), The drier the better; there is less water to pay for and to transport; (2) The lighter the colour, the better also, it is less completely decomposed; (3) If it has not a strong ammoniacal smell, it ought to give a smell when a spoonful of it is mixed with a spoonful of slaked lime in a wine glass; (4) When put into a tumbler with water, stirred well about, and the water and fine matter poured off, it ought to leave little sand or stones; (5) When heated to redness in the air till all the animal matter is burned away, the ash should nearly all dissolve in muriatic acid. The unsoluble matter is useless sand, or earthy adulterations; (6) In looking at the numbers in a published analysis of a Peruvian guano, those representing the water should be small; the organic matter containing ammonia should approach to 50 or 60 per cent.; and the common salt and sulphate of soda ought not to form more than 5 or 6 per cent. of the weight of the guano."

Respecting the analysis of the same, "the following mode of testing it," writes the second author, "is not only easy of performance, but will yield you sufficiently accurate results:

"Take 100 grains of the suspected sample, spread it carefully on a piece of writing paper, and lay it on the

hob, which must not be so hot as to char the paper. When perfectly dry weigh it again; the loss of weight is the amount of moisture it contained, with a very small quantity of ammonia, which would be driven off by the heat along with the water. Then take the same dried and weighed sample, place it upon a piece of sheet-iron, and heat it over a bright fire until nothing but a white or grey ash remains; take it off the fire, allow it to cool, sweep it carefully into the scale, and weigh it again; the loss indicates the amount of ammoniacal salts and organic matter. The ash must now be transferred into a tea-cup, and well mixed with half an ounce of spirit of salt (muriatic acid). If chalk has been mixed with the guano violent effervescence will take place; if not, the effervescence will be very slight indeed. After this has been allowed to stand on the warm hob for five or ten minutes the dissolved portion must be well washed with clean water; the eye will then easily be able to detect sand or brick-dust, if there be any, which will remain at the bottom of the cup, the acid not being able to dissolve either of these. This residue must be carefully collected, dried, and weighed, which, of course, will give you the per-centage of sand and rubbish, and the difference in weight will give the amount of the soluble salts (phosphates of lime, magnesia, &c.), minus the ammonia, which was driven off by the burning on iron plate. To give some idea of the proportions, 100 grains of good Peruvian guano ought to weigh ninety grains after being dried on the paper, thirty-four grains after being burnt on the plate, and about one grain when perfectly dry, after being treated with spirit of salt."

PART IV.

MISCELLANEOUS MANURES.

SALTS OF AMMONIA—SALTS OF MAGNESIA—SALTS OF POTASH—SALTS OF SODA—"COMMON SALT"—LIME AND ITS COMPOUNDS—"OOZE."

IN this order are enumerated several of those fertilisers which command "high" prices when compared to the other manures in general. Therefore we find them not so great in demand as the cheaper and more popular fertilisers—farmyard dung, bones, &c.

SECTION I.

SALTS OF AMMONIA.

AMMONIA consists of the elements of nitrogen and hydrogen in the proportion of three parts by bulk of hydrogen gas, and one part of nitrogen gas.

This substance is frequently formed during the putrefaction of organic bodies. In volcanic regions it is naturally produced through the agency of subterranean fires. A convenient source from which it is ofttimes obtained is in the "ammoniacal liquor" of gas-works. But from time immemorial the substance known as "sal ammoniac" (ammonium chloride, NH_4Cl.) has been prepared in the district of Ammonia between Libya and Egypt, from the soot formed by burning camel's dung.

As a rule our crops usually appear much invigorated

after a thunder-shower. "This is no doubt partly due to the nitrate of ammonia contained in the water; the electricity of the atmosphere has united a small quantity of the oxygen and nitrogen in the atmosphere, forming nitric acid, and this uniting with the ammonia, forming nitrate of ammonia, which is brought down by the rain, and thus stimulates our crops."

In the employment of these salts some little judiciousness is requisite on the part of the agriculturist, as, when farinaceous crops have been subjected to a too liberal supply of this species of fertilisers, injury instead of benefit has been the result. To green crops these compounds will be found of great service; but when fruits, tubers, farinaceous seeds, &c.—of which starch and sugar form a material part—are the desired products, the distribution of these salts should be just sufficient to produce a healthy and vigorous growth, without inducing over luxuriance or rankness.

Ammoniacal Liquor.—This compound is obtained from the gas-works, and is an impure solution of the carbonate and acetate of ammonia. Adverting to this substance and its properties, one gentleman observes:

"It is of various degrees of strength, and, therefore, if applied to the land alone, it must be diluted with a variable proportion of water. It often contains ammonia enough to yield, when saturated with spirit of salt, as much as a pound and a half of sal ammoniac from a single gallon. That of the London gas-works is said to yield, when saturated with sulphuric acid, about fourteen ounces of ammonia from the gallon.

"To grass land this ammoniacal liquor may be applied with great advantage by means of a water-cart, being previously diluted with from three to five times its bulk of water. If too strong it will burn up the grass at first, especially if the weather be dry; but, on the return of

rain, the herbage will again spring up with increased luxuriance.

"On arable land it may be applied with profit to the young wheat or other corn by the water-cart, or it may be dried up by any porous material, and thus put into the turnip or potato drills. A friend in Northamptonshire writes me that 200 gallons of ammoniacal liquor per imperial acre, *drunk up* by sawdust and put into the drills, has given him an excellent crop of turnips. This manuring, however, cannot be expected to keep the land in heart. A certain proportion of bone dust should be mixed with this ammoniated sawdust, or else the corn crops should afterwards be top-dressed with rape-dust, guano, or bones. If, indeed, the land be already *bone sick*, the saturated sawdust may be used alone, or with a mixture of wood or peat ashes for one rotation.

"The ammoniacal liquor may also be used advantageously to promote the fermentation of peat, sawdust, and other composts, or it may be added to the ordinary dung-hill, or to the liquid manure of the farmyard, and applied along with it to the land."

As an eradicator of moss from old grass lands, ammoniacal liquor is described as being more permanent in its effects than lime; whilst on those soils infested with slugs an application of the liquor immediately after the clearing away of the crop, has been found most effectual towards extirpating these pests.

In placing the various salts of ammonia before my readers, I cannot do better than quote the words of that person of authority upon agricultural chemistry, Mr. J. F. W. Johnston. In illustrating their respective properties, &c., he remarks:

"*Carbonate of ammonia* is the common smelling salts of the shops. It exists in the 'ammoniacal liquor,' . . . and is very useful, in a diluted state, in promoting vegetation.

It is too expensive, however, in the form in which it is at present sold, to be of much use to the practical farmer. An ounce of it dissolved in a gallon of water, gives a solution which destroys insects on rose trees and other plants, and adds, to their luxuriance at the same time. A few pieces laid on a plate and allowed to evaporate slowly into the atmosphere of a conservatory, are said to add greatly to the green and healthy appearance of the plants.

"*Sal ammoniac.*—The same may be said of muriate of ammonia, the sal ammoniac of the shops. Though experiment has shown that this substance exercises a very beneficial influence on the growth of our cultivated crops, yet the pure salt is too high in price to admit its being economically used in ordinary husbandry. An impure variety, however, is prepared from gas liquor, which is sold at about 15*s.* a hundredweight.

"*Sulphate of ammonia* is now manufactured at a comparatively cheap rate, and is sold at 16*l.* a ton. This salt may be applied with advantage, especially to soils which are locally called *deaf*, which contain, that is, much inert vegetable matter, and to such as are naturally rich in phosphates. It may also be mixed with bones, rape-dust, or wood-ashes, and put into the turnip or potato drills, or it may be used as a top-dressing in spring to sickly crops of corn.

"A case is mentioned of a field being manured for wheat, in part with ordinary farmyard manure, and in part with 1½ cwt. per imperial acre (cost 1*l.* 2*s.*) of sulphate of ammonia—when the produce of the former was twenty-four, and of the latter thirty-three bushels per imperial acre. In other cases, also, it has been found a profitable application, both to young corn and to meadow hay.

"Faded flowers when introduced into a solution of sulphate of ammonia, are said to be perfectly restored and revivified.

"*Steeping of seeds in the salts of ammonia.*—The salts of ammonia, especially sal-ammoniac and the sulphate of ammonia, have been strongly recommended as steeps for seed-corn. They have in many cases been found very advantageous in hastening germination, and in increasing the after luxuriance of the crop. Thus, in one experiment, seeds of wheat steeped in the sulphate of ammonia on the 5th of July, had by the 10th of August tillered into nine, ten, and eleven stems of nearly equal vigour, while unprepared seed had not tillered into more than two, three, or four stems.

"Sal-ammoniac has a similar effect. In Upper India it is prepared by heating together camel's dung and sea salt, and is used in the plains, among other purposes, for the steeping of seeds.

"It is to be observed, however, that neither when applied directly as a manure to the growing crops, nor when used as a steep for the seed, can the salts of ammonia alone bring a plant to maturity. They tend to hasten its growth, *if all its other wants can be readily supplied by the soil*; but if this is not the case, a quick decay will succeed a short-lived luxuriance.

"The last-mentioned fact, as well as the general value of the salts of ammonia, is illustrated by the results of some experiments made by Mr. Lawes at Rothampstead, in Herefordshire. He sowed wheat for three successive years on the same piece of ground, applying only mineral manures the first year, and only ammoniacal manures the second and third years. The following were the results:—

	Application per Imperial Acre.	Produce. Grain.	Straw.
1844.	Superphosphate of lime, 560lb. } Silicate of potash, 220lb... ... } ...	16 bushels	1112lb.
1845.	Sulphate of ammonia, 1½ cwt... } Muriate of „ 1½ „ ... } ...	31½ „	4266lb.
1846.	Sulphate of ammonia, 2 „	27 „	2244lb.

Thus, upon a soil already rich in mineral manure, the application of salts of ammonia nearly doubled the crop of grain in 1845, and quadrupled that of straw; and in 1846, added again one-half to the grain above 1844, and doubled the straw. In each case, however, some allowance must probably be made for the influence of natural varieties in the seasons.

"As to the necessity of nitrogen to the wheat crop, Mr. Lawes concludes, from numerous experiments, that *upon his soil and in his locality*, five pounds of ammonia—or four of nitrogen, in some other available form—are 'required for the production of every bushel of wheat beyond the natural yield of the soil and season.'* But as a bushel of wheat contains only about 1lb. of nitrogen (equal to 1⅕lb. of ammonia), it is obvious that, if this estimate be correct, the greater part of the nitrogen is lost to the farmer. This subject, therefore, is open to investigation."

SECTION II.

Salts of Magnesia.

Magnesia is a substance which scarcely exists in nature in a pure state. It is therefore prepared from some of its salts. Most fertile soils contain more or less of this ingredient.

Carbonate of Magnesia is found in the ashes of a great number of plants—in some it constitutes a sixth part of the weight of their ash. Those lands in which this salt predominates, are usually styled "thirsty soils," owing to the avidity with which they absorb moisture.

Sulphate of Magnesia, or Epsom salts, exists in all soils

* *Journal of Royal Agricultural Society of England*, viii., 246.

which are formed from, or exist in the vicinity of magnesian rocks. In some soils it forms such a large constituent as to form during dry weather a crust over the surface by the evaporation of moisture. This substance may be applied with benefit to clover and corn crops. For potatoes, also, it has been found very advantageous.

Phosphate of Magnesia is also an important manure, it abounds in most soils; also in animal solids and fluids, likewise in the ashes of grain crops. As a fertiliser for the potato, this compound has been highly recommended. One of our agricultural writers, in recommending its admixture with phosphate of ammonia, thus expounds his views: "Attention to the requirements of nature," says he, "will indicate what mixtures may be tried with the hope of success, and even what mixtures may be likely to prove *specific* manures. Thus it is known by analysis that the seeds of plants—the grain of our corn crops, for example—contain much nitrogen in their gluten, and that the ash of grain is rich in phosphoric acid and magnesia. It is natural to suppose, therefore, that the application to growing corn of a mixture capable of specially supplying these three substances would particularly act in filling the ear. A saline compound known by the name of phosphate of magnesia and ammonia, containing the two phosphates united,* is fitted for this purpose, and was consequently recommended for trial.

"Experiments, recently made, show that it exercises a powerful influence, especially upon Indian corn. Applied at the rate of 130 to 260lb. per acre, it had also a very favourable, though less marked influence upon wheat. Upon Indian corn, at the rate of 3 cwt. per acre, it

* It is prepared by pouring mixed solutions of sulphate of magnesia and sulphate of ammonia into a solution of the common phosphate of soda of the shops.

increased the crop of grain six times, and of straw three times. A constant effect is to increase the weight of the grain per bushel as common salt does; and, like many other substances, it produces most marked effects upon poor and worn-out soils.

SECTION III.

Salts of Potash.

"The term potass originated from the alkali so named being procured by burning vegetables to ashes in large iron pots. It is, by some, called potassa, for uniformity of termination. It is found in the ashes of all inland plants, but different species vary considerably in the proportions of potass which they contain. Boxwood, for example, and aspen, contain only sixty or eighty pounds of potass in every thousand pounds weight of the wood; while the stalks of sun-flower, fumitory or wormwood, contain from 350 to 750 pounds in every thousand. The articles sold in the shops under the names of potash and pearlash, both consist of potass combined with carbonic acid gas, and mixed with various impurities:" (Prof. Rennie.)

As I have already commented upon the subject of potash in the article upon "wood-ashes" (page 46), and further elucidated its qualities in the section on guano (page 80) in this work, any further remarks pertaining to this salt must be as concise as possible.

As many species of crops require a large amount of potash for their food—and the only source from whence this ingredient can be obtained by them being the soil in which they exist—it becomes obvious that if we desire to reap uncommonly excellent crops, the land must contain

a certain quantity of this salt. Therefore, if not already held in sufficient proportion by the ground, it must be then applied by human agencies. Beans, peas, potatoes, &c., are the vegetables which require a large portion of this alkali as a constituent of the soil ere they can be expected to produce heavy crops. Davy asserts that "all kinds of grasses, the *equisetaceæ* for example, contain, in the outer parts of their leaves and stalks, a large quantity of silicic acid (silica) and potash in the form of acid silicate of potash. The proportion of this salt does not vary perceptibly in the soil of corn-fields, because it is again conveyed to them as manure, in the form of putrefying straw. But this is not the case in a meadow; and hence we never find a luxuriant crop of grass on sandy and calcareous soils, which contain little potass, evidently because one of the constituents essential to the growth of the plants is wanting."

Nitrate of Potash.—This salt is familiar to many under the name of "saltpetre," and is obtained principally from the East Indies, where in such districts as Tirhût, in Bengal, it appears on the surface of the ground. It is also procured in Ceylon, Persia, Egypt, and even, it is asserted, in Spain; but the "saltpetre" which reaches England, is principally brought from India in an impure condition—holding about 70 per cent. of pure nitre.

This substance possesses great merits as a fertiliser, especially upon young vegetation. Applied to grass, wheat, oats, &c., at the rate of 1 to $1\frac{1}{2}$ cwt. per acre, it produces leaves of a splendid dark-green colour, causing the crop to spring up with great rapidity. But, great care should be exercised in the distribution of this manure, for, if too liberally bestowed, or even unevenly applied as to be strewn in patches, it is almost certain to "*burn*" the plants. I have been informed that many farmers pursue the system of mixing the "saltpetre" with such ingredients as dry

vegetable mould, bone dust, &c.; and those who have tried this method always continue to adopt such a course; and further acquaint me that, besides being a much safer and cheaper mode, they find the mixture to be even more beneficial than when the nitrate is applied individually.

Sulphate of Potash is in general, too expensive to permit of general utilization; but for leguminous and root crops it has been proved very advantageous, especially when mixed, as the nitrate, with other ingredients into a compost and thus employed.

Carbonate of Potash or the common pearlash forms a first-class fertiliser. For promoting the growth of strawberries it has been specially recommended.

SECTION IV.

Salts of Soda.

The alkali soda occurs in natural beds in Egypt. "In England it is procured by a preparation of borilla or kelp, or by boiling carbonate and quicklime together, the carbonate being obtained by an elaborate process from the boiling of sea-water."

Carbonate of Soda.—This salt, in the form of soda-ash, it is demonstrated, has been employed with success in eradicating the wire-worm. Applied as a top-dressing on clover and grass lands it has proved very beneficial. Made into a compost with an equal proportion of bone-dust or guano, this mixture, applied at the rate of about $1\frac{1}{2}$ cwt. to each acre, has been found advantageous to the potato and turnip crops.

Sulphate of soda—commonly denominated "Glauber's salt"—seems to afford in many instances some little satisfaction as a fertiliser, especially as a stimulant to potatoes.

When mixed with sulphate of ammonia in the following proportion—

$1\frac{1}{2}$ cwt. of sulphate of soda.
$\frac{3}{4}$ „ of sulphate of ammonia.

Total $2\frac{1}{4}$

and this amount ($2\frac{1}{4}$ cwt.) applied to each acre, a remarkable increase in the crop has been observed. Mixing nitrate of soda with the sulphate of the same salt has produced on many grounds *remarkably* heavy crops of potatoes. Even when the sulphate has been used alone to beans at the rate of $1\frac{1}{2}$ cwt. to the acre, the increase in the crop has been found to be sixteen bushels per acre more than the other portion of the field where this fertiliser was not applied.

*Nitrate of Soda.**—This salt, sometimes known as "cubicpetre," possesses properties similar to "saltpetre" (nitrate of potash), differing chiefly from the latter substance by its greater solubility. It is distinguishable from the former by its crystals being of a rhomboid form, whilst those of saltpetre are six-sided prisms.

The "cubicpetre" of commerce is imported from South America, where it occurs in immense deposits in the districts of Atacama and Tarapaca. Darwin asserts that a great portion of the southern regions of that vast continent consists of this substance impregnated with other salts. He informs us of one deposit which was found to consist of one hard stratum between two and three feet thick, and about one hundred and fifty miles in length. From the first year (1830) which witnessed its importation its sales have been augmented to an enormous extent, until at the present date this salt is now enumerated amongst the principal commodities imported into the

* "A Few Notes Respecting Nitrate of Soda" (by the author); vide the *Field*, Dec. 6, 1879.

British wholesale market. Chemists prepare it in the laboratory by dissolving sodium carbonate in water, neutralising with nitric acid, and evaporating the solution, when crystals appear, which are sodium nitrate ($NaNO_3$), or, as a more popular nomenclature, "nitrate of soda."

Like its many contemporaries this manure cannot escape the perplexing position of being denominated both "beneficial" and "unbeneficial" in its action, simply through that ever-appearing want of more scientific understanding upon the part of the farmer. *Nitrate of soda is an attracter of moisture from the air.* This sentence, simple in itself, reveals to us much knowledge, if but thoroughly comprehended. Perceptibility, aided by inference, enables us to perceive—as experiments have also proved—that as "an attracter" of moisture from the atmosphere it must necessarily be conducive towards causing the land acted upon to become more moist, more humid than hitherto. Then to apply it to soils already "wet" and "cold" must be but aggravating the bane, instead of administering the desired antidote. Common sense, therefore, tells us it is to light, warm soils that we must look for benefit to crops by its application, whilst to cold, clayey land, on the contrary, it will almost invariably be found but needless expense. So with this fact once established the few further remarks will pertain to its applicability upon "light," warm land.

If applied alone theory, corroborated by experiments, has proved that upon no crop does this manure exercise so beneficial an action as upon grass. Upon turnips it has been condemned as being almost a complete failure; and, although upon cereals (wheat, barley, &c.) it promotes a stimulating activity, still it is accompanied by several serious objections which render its application undesirable. Let us illustrate these statements more fully. When applied to corn crops it gives increased

luxuriance, and greatly promotes the growth of the straw, whilst it certainly also increases the size of the ear. But this rapid growth in many districts also accelerates the tendency to mildew. It is apt also to cause the straw to become feeble, making the crop more liable to be "laid" by the stormy elements: so that if subjected to rough weather when approaching maturity the crop may be damaged to a considerable degree. But in the generality of cases we have a remedy for this in the simple admixture of "common salt" with the "cubicpetre" in the proportion of two hundredweight of common salt to one hundredweight of nitrate of soda. By such a mixture the growth of the straw is still promoted through the action of the nitrate, whilst simultaneously the common salt strengthens and brightens the stem, thereby giving it weight to stand—probably preventing the appearance of mildew, and also augmenting the weight of the grain. But, as hitherto demonstrated, it is upon grass crops that when applied alone its efficacy is exhibited so powerfully. One gentleman, giving an account of its effects upon his own land, tells us that upon one of his fields he top-dressed half of it with the nitrate; on the other half he allowed the crops to grow without any application of manure. In mowing the field ninety square yards of the grass grown with the aid of the "cubicpetre" were weighed and found to be 420lb. The same quantity of yards from that part of the field which had not been dressed with the substance were likewise weighed, when the total product was found to be only 196lb. Many more instances favouring the application of the nitrate might be adduced; but the above example will suffice as a general demonstration of its superior adaptability for grass crops. For land clover-sick this article, in conjunction with other ingredients to form the following composition, has been found an effectual remedy:

	Cwt.
Nitrate of soda	3
Gypsum	5
Wood-ashes	20
	28

For potatoes we have it recommended in the following mixture:

	Cwt.
Nitrate of soda	¾
Sulphate of soda	¾
	1½

This quantity (1½ cwt) to be applied per acre.

Some persons assert that with an admixture of common salt they have found it to be superior to guano; but such statements we must accept with some reserve. Like other manures this substance is liable to be much adulterated. Common salt is the article generally employed, which last cheap substance, by its illegitimate admixture with the dearer nitrate, enables the fraudulent dealer to amass more profit than is usually permitted to those interested in the sale of this valuable commodity. Detection of its adulteration by common salt can be easily obtained by the following simple method: Dissolve a little of the suspected sample in water, and add to the solution a little nitrate of silver. If common salt be present in it a white precipitate will be formed, the chlorine of the common salt uniting with the silver, forming the insoluble chloride of silver. Or even by throwing nitrate of soda upon the fire we can form an approximate idea. If free from impurities, when thrown thereon it should produce no noise, but only cause the blaze to become more bright. If adulterated with common salt a crackling noise will be produced.

SECTION V.

Common Salt.

This substance possesses, in certain districts, great fertilising properties; but, like many other manures, some judiciousness must be displayed in its employment, else if applied too copiously it proves detrimental to vegetation. The advantage conferred upon crops by salt abounding in the soil appears to have been appreciated by even such an early writer as Pliny. In his "Natural History," book 21, chap. 7, he affirms "that cattle have an avidity for a salt pasture, and that cows give more milk, and that the milk is much more pleasant for curding into cheese than upon ground not of a saline nature."

Passing through other works from such authors as "Old Markham, the Izaak Walton of Agriculture," Sir Hugh Platt, Christopher Packe, Lord Bacon, Evelyn, Lewenhock, &c., who all allude to the virtues possessed by salt: there was published in the year 1738, a work entitled "The Practical Husbandman," in which pages are demonstrated several important facts relative to the utilisation of salt upon lands, which I consider well worthy of being here inserted: "Salt," remarks the writer, "certainly sweetens the grass much; and it may, on all such occasions, be mixed with a proper quantity of dung, which is more sulphurous than salt, and will make grass shoot away much faster than any other manure. Lime, in its own nature, makes grass sour, but when mixed with salt, that acidity will be taken away.

"As to the proportion of salt to be used on land, it ought to be according to the nature of it; cold, wet clayey land requiring more; and loose soft land, though it be poor, requiring less. Again, the proportion of salt ought to be either more or less, according to the crops of grass

or grain you would improve. For cold, wet, and spewey land, ten loads of dung, six of earth, and eight bushels of salt, per acre.

"For lean, hungry, sandy land, fourteen loads of pond earth, six loads of dung, and six bushels of salt per acre, when employed for corn or grazing."

"For meadow land, fourteen or fifteen loads of dung, five bushels of salt, and four of pond earth."

Amidst the many works bearing upon this subject, the article by Dr. Voelcker, in the last number of "Blackie's Encyclopædia of Agriculture" appears to my views so perspicuous in its general excellence that my earnest desire to aid the economical agriculturist as much as possible must be my excuse for transmitting the same to these pages at a somewhat unusual length."

"Salt," observes this eminent chemist, "is largely employed for manuring purposes, and there can therefore be little doubt, that in many cases it produces a sensible improvement in various crops. Its use has been particularly recommended for the cereal crops; and numerous experiments have been published from time to time, in which the application of salt has produced a considerable increase in the yield of wheat, barley, and oats. Thus Mr. C. Johnson found it answer exceedingly well on a light and gravelly soil at Great Totham, in Essex. The produce per acre, on a part which had not been manured for four years, was found to be 17 bushels and 26lb.; and on a part, which he manured with five bushels of salt per acre, and which likewise had not received any manure whatever for four years, the yield of wheat amounted to 26 bushels and 12lb. In a comparative experiment on a part which he manured with stable dung, to a crop of potatoes in the preceding year, he obtained 26 bushels and 52lb. Mr. C. Johnson is, accordingly, a great advocate for wheat, and recommends it to be applied

some time before sowing the seed, in a dose of no less than ten bushels, and not more than twenty bushels per acre. Mr. G. Sinclair, Mr. Fleming of Barochan, Mr. Hannam, and many others, speak highly of salt as manure for wheat. The use of salt was found less beneficial by Mr. Fleming on oats. In an experimental trial the produce of the unsalted portion of the field was 51 bushels, and that of the portion manured with 3cwt. of salt, 53 bushels; the increase thus amounted to 2 bushels only. On barley, a very large increase was obtained by Mr. Ransome, in Suffolk. No salt gave 30 bushels; and 16 bushels of salt raised the produce to 51 bushels. We abstain from mentioning any other experiments in which salt has been tried on corn crops, because they have, for the greater part, not been conducted with the requisite care and accuracy. Salt is said to give strength to the straw, and theoretical reasoning leads us to expect this; but whether it is the case or not, has never been determined as yet by any direct experiments. Neither theoretical speculation, vague statements, nor solitary practical observations, can establish so important a fact, which can only be proved by the rigorous tests of a series of well-conducted comparative experiments. The use of salt for root crops has also been highly recommended; and in some experiments by Mr. M'Lean, of Braidwood, Midlothian, a considerable increase in the turnip crop was obtained by the addition of 4cwt. of salt to thirty carts of dung per acre. Root crops, especially mangolds, contain a considerable proportion of common salt, and it is therefore very probable that they will be benefited by a generous supply. It has been estimated by Mr. Way (*Royal Agricultural Society Journal*, viii., p. 186), that turnips contain, according to the average of his trials, about 2lb. of common salt in every ton of bulbs; and mangold wurzel 6½lb. These analytical remarks lead us to expect that salt will

be highly favourable to the luxuriant growth of root crops, and in an especial manner to that of mangold wurzel. It is well known that a saturated solution of salt is capable of killing weeds; and we know further, that some plants are injured by a dose of salt, which decidedly improves others. There have been as yet few precise experiments, with a view of determining in what quantities, and under what conditions, salt exercises a beneficial effect upon our various cultivated crops. That salt affects various plants differently will be seen from a series of experiments which were made some years ago . . . with a view of ascertaining in what quantities salt exercises an injurious, and when a beneficial effect. The following is the summary of the results of these experiments:

"1. Salt solutions, containing three grains of salt per imperial pint, or six grains, twelve grains, and even twenty-four grains of salt per pint, produced no injurious effects on cabbage, field beans, onions, lentils, chickweed (*Stellaria media*), groundsel (*Senecio vulgaris*), thistle (*Carduus pratensis*), annual meadow grass (*Poa annua*), radishes (common long red variety), which were regularly watered with these solutions during two months. Plants of *Anthoxanthum odoratum* (sweet-scented vernal) were killed by a solution containing twenty-four grains of salt per pint, after the lapse of one month.

"2. Such weak solutions appeared to benefit most plants experimented upon, especially cabbages, radishes, and lentils. All had a fresher and more luxuriant appearance than those watered with rain water only. The lentils, which were watered with a salt solution containing twenty-four grains per pint, were nearly one-half larger in size than those watered with six grains of salt to the pint, and these again appeared more vigorous than the lentils which received no salt at all.

"3. Salt solutions, containing forty-eight grains of salt, exercised a prejudicial effect in the course of a month on lentils, chickweed, groundsel, and the annual meadow grass. They had no injurious effects on cabbages, field beans, onions, radishes, and thistles.

"4. Salt solutions, containing ninety-six grains of salt per pint, exercised an injurious effect upon cabbages and field beans, but did not injure onions, radishes, and thistles.

"5. Cabbages will continue to grow, though sickly, when watered regularly during the month with a salt solution, containing 192 grains of salt per pint, and even when watered with a solution containing 384 grains of salt per pint.

"6. A solution of salt, containing 192 grains per pint, now proved prejudicial to onions regularly watered with it during one month.

"7. A solution, containing 24 grains of salt to the pint, decidedly benefited radishes, onions, lentils, and cabbages.

"8. Grasses are affected by salt more readily than any of the plants experimented upon.

"9. Bulbous plants, and plants with succulent leaves are especially benefited by the application of salt.

"Many of the plants in these experiments had taken up so large a quantity of salt, that they tasted quite saline; but, notwithstanding this, they grew healthily. This evidently shows that salt, in a moderately dilute solution, can be taken up by many plants without exercising a pernicious effect. In many cases in which salt was applied to the land, it has failed to produce any sensible improvement of the growing crop; but in examining the circumstances under which it was unsuccessfully employed, we shall frequently be able to point out the cause of the failure, if we pay due regard to the following considerations:

"1. The neighbourhood of the sea must necessarily interfere with its action. On land situated along or near the sea coast, or which is exposed to the action of prevailing sea winds, the application of salt will prove useless; because the soil in such localities contains already more than is sufficient to satisfy the wants of the growing crops. It is well known that the spray of the sea is constantly borne by the winds, and sometimes strewed upon the land at a great distance. Moreover, the clouds which form over the sea always contain a greater or less quantity of salt, which will be deposited in the soil by the rain. In England, rain seldom falls anywhere in which a sensible proportion of common salt cannot be detected; and this circumstance no doubt explains at once why, on the whole, the application of salt to the land, in continental countries, has been attended with much better results than in England. Calculating the fall of rain at 31in. per annum, Dr. Madden has determined, by analysis, that the rain which falls at Penicuik brings down upon each acre of land in that neighbourhood 641lb., or nearly 6cwt., of salt. Dr. Madden has shown also, that nearly all the failures which are described in the *Quarterly Journal of Agriculture*, Sept., 1842, p. 574, were experienced on farms which are more or less freely exposed to the winds from the east or west sea.

"2. Some soils, in inland districts also, contain much salt; and the presence of deposits of salt, or the occurrence of salt springs, affords excellent indications, that on land; in the neighbourhood of localities where such deposits or saline springs occur, the application of salt will, in all likelihood, be unprofitable.

"3. It must not be forgotten that salt is not a universal manure, and that for this reason it cannot supersede the use of other manures. Indeed, if land is out of condition, salt applied alone will do little to raise its fertility.

"4. On farms where salt is given with the food to the stock, the manure which is made must necessarily contain much salt, so much, indeed, that in many instances the special application of salt to the land which has been dressed with such manure will be altogether superfluous.

"5. In dry seasons common salt, like all other saline manures, exercises no effect if it be supplied to the land in moderate quantities, and may prove prejudicial when used in large doses. With respect to the theory of the action of common salt, when applied alone to the land, we would observe that it may exercise a beneficial effect upon most plants, for the following reasons:

"(1.) Common salt exists in greater or less proportion as such in all our cultivated plants. Several, naturally growing near the sea coast, require considerable quantities for coming to perfection. One of the functions of salt will therefore be to supply plants with this necessary alimentary constituent.

"(2.) According to Sprengel and Meyen, the leaves of plants give off chlorine in the dark. The chlorine must arise from the decomposition of a chloride, in all probability, from chloride of sodium, or common salt. The soda which is thus produced may act upon the constituents in the sap in a variety of ways, and produce effects highly conducive to the luxuriant growth of plants.

"(3.) It is stated by Berthollet that, in a calcareous soil, common salt is gradually decomposed by the carbonate of lime which the soil contains. By a double decomposition, carbonate of soda and chloride of calcium are formed; and as carbonate of soda has the property of dissolving silica, we can in some measure explain the effects of salt by the circumstance that it applies indirectly silica,

which is so essential a constituent of many plants. Carbonate of soda not only dissolves silica, and may supply it to the plant in a readily available form, but it is also a solvent for phosphoric acid, organic acids, &c., and may, therefore, exercise a beneficial effect by carrying these constituents into the vegetable organism, in combination highly favourable to the healthy condition of plants.

"4. Professor Way has lately shown that silicate of ammonia is much more soluble in a solution of common salt than in pure water. His researches render it very probable that silicate of ammonia fulfils the important function of carrying silica into our cereals, and depositing it on the surface of their leaves and stalks. Now, if silicate of ammonia is really the chief source from which the silica in our cereals is derived, the use of salt in growing corn can be intelligibly explained by the great solubility of silicate of ammonia in a salt solution."

Any further observations of mine, relative to the applicability of common salt for agricultural purposes, would very rightly be judged as superfluous; therefore, the subjoined remarks will be devoted to describing the properties of this fertiliser as determined by two very carefully conducted experiments.

The first of these was undertaken by the late Mr. George Sinclair upon wheat and barley; and to the practical farmer will prove highly interesting and valuable from an economical point. It should be stated that the soil experimented upon was sandy, and each plot contained 36 square feet; the Talavera wheat was drilled into the ground on the 5th of November, and reaped the following August.

Kind of Manure and Mode of applying it.	Manures, quantity per Acre.				Wheat.	
					Produce.	
	Dung, in Tons.	Salt, in Bushels.	Lime, in Bushels.	Oil-cake in Bushels.	Bushels.	Weight of a Bushel.
						lb.
Spit manure applied previous to sowing the seed ...	45				49	57¾
Salt and spit manure, dug in salt mixed with seed ...	45	44			75	58
Salt mixed with soil four inches deep before sowing ...		44			91	59
Salt ,, ,, ,, ...		5½			77	59
Salt sown with seed		5½			73	57
Salt combined with manure, dug in four inches deep ...	45	5½			75	52½
Salt and manure: salt sown with seed, manure dug in	45	5½			95	59
Salt and manure: salt applied to the surface	45	5½			82	57½
Salt simply applied to surface		5½			60	55
Salt and manure: salt applied to the surface	45	44			55	53¾
Salt simply applied to surface...		44			77	56
Salt and lime mixed, and applied with the seed		5½	121		66	56½
Salt and lime mixed, and applied before sowing		5½	120		68	56¾
Salt and lime mixed, and applied to the surface		5½	120		64	56
Lime applied with the seed			120		53	52½
Lime applied to the surface			120		57	54½
Salt, lime, and dung mixed, and applied as a manure ...	90	5½	120		62	56½

TABLE—*continued.*

Kind of Manure, and Mode of applying it.	Manures, quantity per Acre.				Wheat. Produce.	
	Dung, in Tons.	Salt, in Bushels.	Lime, in Bushels.	Oil-cake in Bushels	Bushels.	Weight of a Bushel.
						lb.
Long dung dug in as manure	41				71	56¾
Salt and long dung mixed, and applied as a manure ...	41	22			71	56
Lime and long dung mixed, and applied as a manure ...	41		120		54	57
Salt and long dung mixed, and applied as a manure ...	41	44			57	56
Oil-cake mixed, and applied with the seed				5½	48	56
Oil-cake applied as common manure				5½	73	60
Oil-cake and lime applied as common manure			120	5½	74¼	56¾
Salt and oil-cake mixed, and sown with seed		5½		5½	60¼	—
Salt and oil-cake mixed, and applied as manure		5½		5½	74½	58
Salt, oil-cake, and manure, applied as manure	90	5½		5½	74½	58
Salt, oil-cake, and manure: the salt and oil-cake sown with the seed, manure previously dug in	90	5½		5½	55½	55½
Salt, oil-cake, and lime, applied as manure		5½	120	5½	71	51¼
Salt, oil-cake, and lime, sown with seed		5½	120	5½	55½	55½
Salt, oil-cake, and lime, applied to the surface		5½	120	5½	66	58
Salt applied to the soil in preceding spring		62			44¼	57½
Salt ,, ,, ...		31			26½	47½

The following table exhibits the results of fourteen experiments made by the same gentleman upon barley:

Kind of Manure, and Mode of applying it.	Quantity per Acre.		Produce.	
	Bushels of Salt.	Bushels of Lime.	Bushels.	Weight of a Bushel.
				lb.
Soil without manure of any kind	—	—	12	43¼
Salt sown with the seed	55	—	20	43¾
,, ,, ...	5½	—	20	42½
Salt applied before sowing	33	—	28¾	44¼
,, ,, ...	11	—	28¾	43
,, ,, ...	5½	—	23¾	43
Lime and salt applied before sowing	33	60	9	42¼
,, ,, ...	11	60	22	42¼
,, ,, ...	16½	30	13¾	43
Lime mixed and sown with seed... ...	—	60	18¼	43¼
Lime mixed with soil previous to sowing ...	—	60	18¾	43¼

He experimented also upon oats, but the proportion applied was evidently too great, as the part manured with the salt produced even a less amount of grain than the portion upon which no manure had been employed.

"The following," says the Right Rev. Bishop Russell, "is some experiments made by the Rev. Mr. Cartwright,

with the view of determining the effects of different manures on the same soil and for the same crops, and particularly of salt used as the means of increasing vegetation. The soil in question was a ferruginous sand, which was brought to a proper consistence by a liberal allowance of pond mud.

"In the month of April a portion of the field was laid out in beds, a yard wide and forty yards long. Of these twenty-five were treated as follows:

No.
1. No manure.
2. Salt, one peck and a quarter.
3. Lime, one bushel.
4. Soot, one peck.
5. Wood-ashes, two pecks.
6. Sawdust, three bushels.
7. Malt-dust, two pecks.
8. Peat, three bushels.
9. Decayed leaves, three bushels.
10. Fresh dung, three bushels.
11. Chandler's greaves, three pounds.
12. Salt, lime.
13. Salt, lime, sulphuric acid.
14. Salt, lime, peat.
15. Salt, lime, dung.
16. Salt, lime, gypsum, peat.
17. Salt, soot.
18. Salt, wood-ashes.
19. Salt, sawdust.
20. Salt, malt-dust.
21. Salt, peat.
22. Salt, peat, bone-dust.
23. Salt, decayed leaves.
24. Salt, peat ashes.
25. Salt, chandler's greaves.

"The quantity of each ingredient was the same as when they were used singly. On the same day one row of potatoes was planted in each bed; and that the experiment might be accurately conducted, the number of sets

was the same in all. When the shoots appeared above ground, their comparative excellence was carefully noted. The best row at that period was No. 7, from malt-dust; and the next best was that from chandler's greaves. The most backward, in the month of May, was No. 6, which had been manured with sawdust. On the 21st September the potatoes were taken up, when the produce of each row was as follows:

No.		lb.
17.	Salt and soot	240
11.	Chandler's greaves	220
18.	Salt, wood-ashes	217
16.	Salt, gypsum, lime, peat	199
15.	Salt, lime, dung...	198
2.	Salt	195
25.	Salt, greaves	193
4.	Soot	192
10.	Fresh dung...	192
20.	Salt, malt-dust	189
5.	Wood-ashes	187
23.	Salt, decayed leaves	187
24.	Salt, peat ashes	185
7.	Malt-dust	184
14.	Salt, lime, peat	183
19.	Salt, sawdust	180
22.	Salt, peat, bone-dust...	178
9.	Decayed leaves	175
13.	Salt, lime, sulphuric acid	175
21.	Salt, peat	171
8.	Peat	169
12.	Salt, lime	167
1.	No manure...	157
6.	Sawdust	155
3.	Lime	150

"It is remarked by the author of these experiments as a singular circumstance, that of ten different manures, most of which are of acknowledged efficacy, salt, the effects of which were doubtful, is, with one exception superior to them all; while in combination with other substances

none, except chandler's greaves, was injured by it. The energy of salt when combined with soot was very striking. But Mr. Cartwright was disposed to ascribe its effects rather to the power which it possesses of attracting moisture from the atmosphere than to any chemical action between the two substances; for the beds on which the salt was used continued visibly moister than the others, even for weeks after its application. Another circumstance noticed is, that the plants which grew on the beds manured with salt, were of a paler green than the rest, but equally luxuriant; which appearance he at first regarded as an indication of want of vigour, an opinion by no means confirmed by the result. He found too that wherever salt was applied, whether by itself or in combination with other substances, the roots were perfectly clean."

SECTION VI.

Lime and its Compound.

The substance familiar to us by the nomenclature of "lime" consists of the metal calcium with oxygen, and is compounded from these two ingredients in something like the following proportions:

Calcium	72
Oxygen...	28
	100

Lime does not exist in nature in a pure state. Its strong affinity for carbonic acid causes it to greedily absorb that compound from the atmosphere, through which means, it becomes converted into carbonate of lime, which exists in nature as limestone, chalk, marble, &c.

Lime also frequently occurs impregnated with other acids, such as sulphuric (forming gypsum, &c.), phosphoric (forming phosphate of lime), &c.

The common varieties of lime utilized by the British agriculturists, are produced by calcining either the chalk or limestone, when, by the attainment of a sufficiently high temperature, the carbonic acid is expelled, leaving the pure lime as residue. In this state it is known as "burnt-lime, "quick-lime," "caustic-lime," "hot-lime," &c., and now possesses properties very different to unburnt limestone. If water be poured upon this quick-lime, much heat, accompanied by steam, is evolved; the substance swells, cracks, and ultimately falls to a fine white powder usually termed "hydrate of lime." This powdery mass is dry to appearance, but in reality, it is not so; water in an invisible form is combined with it. If left exposed to the atmosphere while in this condition, it has a strong tendency to imbibe the moisture therefrom, until at length it becomes as heavy as it was previous to its calcination. When this state is reached, it is familiarly recognized as "mild-lime," and as the name implies, it now acts but mildly—in a similar manner as chalk—upon the land.

It is a curious fact that the use of lime, as a manure, undoubtedly had its origin in Europe. It does not appear ever to have been appreciated by either the races of Asia or Africa, and yet our European ancestors evidently employed it during the remotest periods of civilisation. We, of the present generation, are prone to look upon it as ranking amidst the most important of fertilisers usually applied to the land.

Its salts have been discovered in the ashes of all plants, therefore, if vegetable animation is to be sustained, lime—in some form or other—must be held by the soil.

But "limes" differ very perceptibly in their constituents, so that some little caution is requisite to prevent mischief.

Some specimens hold magnesia as a large component, which substance, through its exceedingly slowly absorption of carbonic acid, remains in a caustic form for a long period, thereby proving very injurious to the roots of the plants upon which it may happen to be employed. It is only where pure, however, that magnesia is pernicious; for by exposure to the air it gradually becomes transmitted into carbonate of magnesia, when it is prejudicial no longer to vegetation.

All soils, in general, are benefited more or less by an application of lime; providing they are not extremely deficient in organic matter, and not containing already too great an amount of calcareous ingredients. As lime exercises its greatest powers upon organised substances, we discern that if applied to land supporting therein no vegetable or animal matters whatsoever, there is thus nothing for it to "act" upon, and therefore, dormant, it remains, useless to the land, until at length, it either becomes transformed into chalk, or else washed into the sub-soil and away by the action of the alluvial elements.

To scrutinise this important subject more closely, I will take three of the principal soils—viz., "peaty," "clayey," and "sandy," and exhibit the beneficialness conferred upon each respectively by a distribution of this fertiliser.

That no species of soil derives greater benefit through the application of lime thereon, than peaty land, is conceded by all agriculturists. Upon ground of this nature, no other manure approaches lime for efficaciousness. Generally abounding, as peat does, with an injurious excess of sulphate of iron and other noxious ingredients, the lime decomposes this mischievous matter, unites itself with the sulphuric acid of the ferruginous compound, and forms the valuable fertiliser, sulphate of lime, or as more generally styled "gypsum." In thus neutralising the injurious acids usually found in this class of land, lime

tends towards removing the "sourness," &c., of the pernicious compounds generally contained therein, thereby rendering them unhurtful to the growth of vegetation.

Upon clayey land, lime acts in a much similar manner; mixed with the heavy adhesive soil, the argillaceous land becomes much more friable, not so susceptible of being injuriously acted upon by the sun, and finally, is rendered much more permeable by the atmospheric gases.

The chief benefits derived by sandy and other light soils, through a strewing of lime, are, it imparts solidity to the land, allows the soil greater facilities for retaining moisture, and also prevents, to a certain extent, the sun from penetrating so deeply into the ground—thereby preventing the roots from being parched through lack of moisture.

On those lands resting upon a quarry of stone, and usually denominated "poor," "thin," "stony," &c., and which have been for a long period under cultivation; an application of lime will be found, almost invariably non-efficacious; but on those soils generally known as "wastes," and never previously tilled, upon these lime acts most expeditiously.

"The quantity of quicklime laid on at a single dressing," remarks an able writer, "and the frequency with which it may be repeated, depend upon the kind of land, upon the depth of the soil, upon the quantity and kind of vegetable matter which the soil contains, and upon the species of culture to which it is subjected. If the land be wet, or badly drained, a larger application is necessary to produce the same effect, and it must be more frequently repeated. But when the soil is thin, a smaller addition will thoroughly impregnate the whole, than where the plough usually descends to the depth of eight or ten inches. On old pasture lands, where the tender grasses live in two or three inches of soil only, a feeble dressing, more frequently repeated, appears to be the more reasonable practice;

though in reclaiming and in laying down land to grass, a heavy first liming is often indispensable.

"In arable culture, larger and less frequent doses are admissible, both because the soil through which the roots penetrate must necessarily be deeper, and because the tendency to sink beyond the reach of the roots is generally counteracted by the frequent turning up of the earth by the plough. Where vegetable matter abounds, much lime may be usefully added; and in stiff clay lands after drawing, its good effects are very remarkable. On light land, chiefly because there is neither moisture nor *vegetable matter* present in sufficient quantity, very large applications of lime are not so usual, and it is generally preferable to add it to such land in the state of compost only.

"The largest doses, however, which are applied in practice, alter in a very immaterial degree the chemical composition of the soil. The best soils generally contain a natural proportion of lime, not fixed in quantity yet scarcely ever wholly wanting. But an ordinary liming, when well mixed up with a deep soil, will rarely amount to *one per cent.* of its entire weight. It requires about 400 bushels (12 to 15 tons) of burned lime per acre to add one per cent. of lime to a soil of twelve inches in depth. If only mixed to a depth of six inches, this quantity would add about two per cent. to the soil.

"Though the form in which lime is applied, the dose laid on, and the interval between the doses vary, yet in Great Britain, at least in those places where lime can be obtained at a reasonable rate, the quantity applied amounts, on an average, to from seven to ten bushels a year.

"The most remarkable visible alterations produced by lime are—upon *pastures*, a greater fineness, sweetness, closeness, and nutritive character of the grasses—on *arable lands*, the improvement in the texture and mellowness

of stiff clays, the more productive crops, their better quality, and the earlier period at which they ripen, compared with those grown upon soils to which no lime has ever been added.

"This influence of lime is well seen when limed is compared with unlimed land, or when soils, which are naturally rich in lime, are compared with such as contain but little. Barley grown on the former is of better malting quality. The turnips of well-limed land are more feeding for both cattle and sheep. And the hill pasture on limestone soils, like those of Derbyshire, continue longer green in autumn, and yield a greater yearly return of milk and cheese than the soils which are produced from sandstone rocks.

"But this superiority gradually diminishes year by year in land artificially limed, till it returns again nearly to its original condition. On analysing the soil when it has reached this state, the lime which had been added is found to be in a great measure gone. In this condition the land must either be limed again, or must be left to produce sickly and unremunerating crops.

"This removal of the lime arises from several causes.

"1. *The lime naturally sinks*, more slowly, perhaps, in arable than in pasture or meadow land, because the plough is continually bringing it to the surface again. But even in arable land, it gets at last beyond the reach of the plough so that either a new dose must be added to the upper soil, or a deeper ploughing must bring it again to the surface.

"2. *The crops carry away a portion of lime from the soil.*— Thus the following crops, including grain and straw, or tops and bulbs, carry off respectively—

								Of lime.
25	bushels	wheat,	about	...	...	...	...	13lb.
40	,,	barley,	,,	...	...	...	...	17lb.
50	,,	oats,	,,	...	...	...	...	22lb.

			Of lime.
20	tons	of turnips, about	118lb.
8	„	potatoes, „	40lb.
2	„	red clover, „	77lb.
2	„	rye grass, „	30lb.

"The above quantities are not constant, and much of the lime is no doubt returned to the land in the straw, the tops, and the manure; yet still the land cannot fail to suffer a certain annual loss of time from this cause.

"3. *The rains wash out lime from the land.*—The rain water that descends upon the land holds in solution carbonic acid which it has absorbed from the air. But water charged with carbonic acid is capable of dissolving carbonate of lime; and thus year after year the rains, as they sink to the drains, or run over the surface, slowly remove a portion of the lime which the soil contains. Acid substances are also formed naturally by the decay of vegetable matter in the land, by which another portion of the lime is rendered easily soluble in water, and therefore readily removable by every shower that falls. It is a necessary consequence of this action of the rains, that lime must be added more frequently, or in larger doses, where much rain falls than where the climate is comparatively dry."

Respecting the season best adapted for the strewing of lime, some diversity of opinion exists upon this subject. But of one fact we may rest assured, and that is, when this fertiliser is to be applied as a top-dressing for pasture land, early in spring or autumn are certainly more suitable periods than summer or winter; for the simple reason that if distributed in hot weather, the grass is so apt to be scorched, while if strewn in winter, the efficaciousness of the manure is supposed to be diminished by the usual frostiness of the season. But in general the most suitable time is computed to be when the fallowing is completed, when it may be either harrowed in or sub-

jected to a *superficial* ploughing. As generally known, the effects of lime are certainly more apparent during the second and third year subsequent to its application than during the first. And it need scarcely be mentioned here that some judiciousness must be displayed in mixing lime with animal manures, as the lime releases the ammonia of the latter substances by usually causing a more rapid decomposition than the crops are capable of appropriating. Of all fertilisers, common salt is evidently one of the best fitted to be mixed with lime. Made up into a composition at the rate of double the quantity of lime to each bushel of salt, this mixture is found to be an excellent manure for potatoes; and further, *such a compost has been declared to be efficacious in enabling the crop to resist the disease* now so prevalent. Applied in one instance at the rate of forty bushels to the acre the portion of the field dressed with this compound was found to be entirely free from disease; whereas the remaining part of the same ground, which had not received an application of this manure, was found to be scarcely worth lifting.

For such leguminous crops as peas and beans, where the soil is deficient in lime, the following compost will be found of great benefit:

Lime	10 bushels.
Superphosphate of lime	2cwt.
Salt	5 bushels.

For crops devastated by the slug, lime is well known as one of the safest and best of specifics. Mixed alternately —in strata—with brine up to any convenient height, and in seven or eight days turned over, well broken and mixed so that the whole mass becomes thoroughly incorporated, this mixture has been recommended for various crops—cabbages especially—and in many instances, is described as having proved "far superior" to farmyard dung.

Sulphate of Lime or gypsum is a compound of 41·5

parts lime with 58·5 parts sulphuric acid; in its natural state it also contains about 20 per cent. of water.

"The manner in which gypsum acts to increase the productiveness of our fields is a subject on which there have been more discussion and controversy than any other connected with agricultural chemistry; indeed, there have hardly been two writers who have advocated the same theory respecting it. Davy regarded it simply as an essential constituent of the plant, and held that it was not decomposed, but that it entered the plant as gypsum. Liebig holds that its chief use is to fix the ammonia of the air. According to his theory, a double composition is effected in the sulphate of lime and the carbonate of ammonia, sulphate of ammonia and carbonate of lime being the result of this decomposition. Hedwig compares the action of gypsum on the food of the plant to the action of the saliva and gastric juice on the food of the animal. That gypsum thrown into stagnant water that contains vegetable and animal substances in a state of decomposition, will cause the production of sulphuretted hydrogen, and will also produce a more rapid decay of the vegetable and animal tissues, has often been noticed. To effect this result, it is evident that the sulphuric acid must be decomposed; the oxygen uniting with the carbon of the organic matter to form carbonic acid, and the sulphate combining with the hydrogen.

"To apply gypsum with a certainty of producing the best results, requires more theoretical and practical knowledge than does the employment of most manures. Composts, and the solid and liquid excrements of animals, can seldom be used without benefit, whatever be the soil in which they are placed, or the crop it is intended to produce. They are, in a manner, universal fertilisers, from the fact that they contain the essential food of almost every plant. But with gypsum the case is very different.

Indeed experience has proved that gypsum of itself is quite inadequate to produce fertility, and that it is only when it acts in conjunction with vegetable manures that its value is most apparent. It is also true that the longer it is used the smaller are the number of crops which are deemed benefited by its application.

"It is now well settled that it promotes the formation of woody fibre and adds to the luxuriance of foliage, and that it protracts the period of the growth of the plant, or in other words, delays the time of its maturity. Dust gypsum on half the area of a clover field and the following distinctive results will ordinarily be observed: The leaves will be longer and of darker colour, the stalks more hardy and consequently less liable to lodge, and the period of blossoming will be delayed several days; the number of flowers being comparatively smaller than in that part of the field not so treated.

"Now all these results are desirable in the production of clover; particularly are they so when sheep-growers bear testimony to the statement that sheep manifest a preference for, and eat with greater avidity, the clover raised under such circumstances.

"On other crops, however, when the object is to produce seeds or fruits, rather than stalks and foliage, the use of this substance would not be desirable; particularly would this be the case where an early harvest is desired. Thus, the use of gypsum has been objected to in the cultivation of strawberries, for the reason that it tended to the production of strawberry hay rather than berries.

"Too large an amount of it applied to potatoes, either in the hill or as a top dressing, has been found to produce a luxuriant growth of tops and comparatively small tubers; but a small quantity placed in the hill or on the sprouts when they are first breaking through the soil, has been found to be highly beneficial. For the production of peas

and beans, probably from the large amount of sulphur they require, the use of gypsum is justly celebrated both for improving the quality and increasing the quantity of the product; the same is also true in relation to the culture of the turnip."—(Prairie Farmer.)

The Chevalier Claussen, some time ago, undertook some very interesting experiments respecting the virtues of this substance in acting as a preventive of the further spreading of the disease amongst potatoes when stored; and considering the fact that it is often the cry of farmers how potatoes, when first stacked for winter use, ostensibly appear perfectly sound, but when broken into some months later, are ofttimes 75 per cent. rotten; it appears strange that this subject has not received more earnest attention at the hands of agricultural authorities. Writing to the *Chemist*, this eminent person observes: "About six weeks since I was engaged in making various experiments on the effect of sulphate of lime on vegetable substances. A portion of the substances then used by me was carelessly thrown aside, and on returning to my experiments about a fortnight afterwards, I was surprised to find that decomposition had not taken place in those portions of the vegetables which had been subjected to the action of sulphate, while those which had not been so treated were completely decayed. Among the articles experimented upon were a number of potatoes, each of which was affected by the prevalent disease; some of these remain sound to the present day, the others have some time since completely rotted away. Subsequently I procured more potatoes, and also some beet roots, the former being, as far as I could judge, all diseased. I divided the potatoes into three portions. One lot I placed in a vessel with a weak solution of sulphuric acid, and from thence I placed them in a solution of weak lime water. In the second lot the process was reversed; that is to say, the potatoes were

first placed in the lime water, and then in the acid. The third lot was left untouched. Ten days afterwards I examined the potatoes, and found, as I expected, that the potatoes which had not been treated with the sulphate were rapidly decaying—those which had been first placed in the solution of lime and then in the acid were more nearly decomposed—while those which had been treated in the mode first described remained as sound as when first taken in hand. Upon being cut open the diseased part of the potatoes was not found to have spread internally, and the flavour of the root was in no degree affected by the application of the process, nor do I think that its germinating power was injured by the effect of the sulphate. The effect upon the beet roots was similar to that produced on the potatoes, and which would seem to be somewhat analogous to that of galvanising metals, viz., protecting the substances from the effect of atmospheric agencies. I may add that muriatic and other acids have been employed by me on other occasions with equal success, the only agents required appearing to be those which will most readily produce a sulphate in contact with the substances required to be preserved. I do not think that any insuperable difficulty exists with respect to the application of the process. The acid I employed was very weak—about one part to two hundred of water; the lime water was about the consistency of milk."

Phosphate of lime, as the name implies, is a combination of phosphoric acid and lime. This substance is present in the seeds of most cultivated plants, therefore we find, almost invariably, that on those soils deficient of this compound, such plants will not thrive.

"When bones are burned in an open fire, they diminish in weight about one-half, and leave behind a white earthy matter, long known by the name of *bone earth*. This bone earth consists chiefly of *phosphate of lime*.

"Bones are known to be an excellent manure, and as our cultivated crops, and especially our corn crops, contain much phosphoric acid, it has been justly concluded that part of their effect is due to the bone earth they contain. Hence the use of burned bones as a manure has been warmly recommended.

"In soils which are poor in phosphate of lime, there is no doubt but burned bones will be likely to benefit the crops of corn; but there are few soils, I think, in which a ton of bone-dust would not produce a better effect than the ash left by an equal weight of bones.

"Phosphate of lime is found as a native mineral in many countries, and has been applied with advantage to the soil. It has lately been met with in the States of New York and New Jersey in sufficient quantity to make it likely to prove a profitable article of import into this country. It has also been discovered in considerable quantity in the marls of the crag of greensand formations of England; and is now dug up in large quantities for agricultural purposes.* In our ordinary limestones it also exists in variable quantities. In a burned lime from Carluke, which is full of fossils, I have found it to the extent of $2\frac{1}{3}$ per cent.; so that every ton of such lime conveys to the land as much phosphate of lime as two bushels of bones. This must modify in a favourable manner the effect of such lime when applied to the land:" (Johnston.)

Superphosphate of Lime.—This substance has lately received much favour at the hands of the British agriculturist. For turnip and grass crop especially it has been highly recommended.

What is sold, however, under the name of superphos-

* Journal of the Royal Agricultural Society, Vol. IX., p. 56, and Vol. XII., p. 93.

phate, is often extensively adulterated. A very simple method of enabling the agriculturist to make his own "superphosphate" has been described by Mr. C. Lawrence, of Cirencester, "I think," says he, "I may offer the following directions to those who have not had any experience in this preparation. For drilling five acres of turnips or swedes procure twenty bushels of half-inch bones crushed in a dry state; this quantity will usually weigh about 800lb.; get 200lb. of the ordinary sulphuric acid of the manufacturer, which would generally be of the specific gravity, 1·840;* add to this acid an equal weight of water, and stir it in an earthen or wooden vessel, pour this very gently over the bones as equally distributed as may be, delivering it close over the bones, as any splashing will destroy clothes, and may damage the operator. When the mixture has laid about two days take it out and form it into a conical heap, and cover it with turf ashes, or such as are commonly prepared on the farm for drilling, in which state it may be left for three or four weeks, to break down more effectually any portions of bone which have not been sufficiently done before. Uncover the heap, and add to the ashes first used as many as will make up the quantity the party usually uses in drilling, whether twenty, thirty, or more bushels per acre, and then mix those and the bone paste very thoroughly together. Form the mixture again into a heap, and cover it with earth, to remain till within a few days of its being required for drilling, when the heap should be again turned over, and every portion of the bone paste then found should be broken down with the spade or fork, in order that the whole should be completely mixed with

* If it be desired to use this manure in a more concentrated state, so that the whole of the bone may be available for the root crop, one part of acid to two parts of bone by weight should be employed.

the ashes. The acid and bones may be mixed in various ways, but, as this is an article required every season, I consider the most efficient and economical, because permanent, receptable is a brick tank formed thus: Dig out the earth in some convenient spot near the homestead, and bottom it and line it with brick (one brick flat is sufficient) set in coal ash, lime, mortar, and pointed in the inside with good fresh Portland cement. For mixing five quarters of bones with the acid at a time, I have found a tank six feet long, three feet wide, and thirty inches deep, a convenient size."

SECTION VII.

"Ooze."

The Rev. Bishop Russell, in his treatise upon agriculture, dwells upon the value—as a fertiliser—of the ooze, mud, or warp, procured at the mouths of rivers, in ponds, and canals. This mud, he affirms, "is of a most enriching nature, and adds to the staple of the soil. It is used as a top-dressing in spring for crops both of grain and grass, more especially for the latter, being at the same time an excellent material for composts. The late Duke of Bridgewater made considerable use of sea-ooze, brought up from the Mersey in barges, by his canals, to lands near Worsley. It has remarked, that wheat raised by means of this manure is little subject to rust, mildew, or any other distemper. In respect to the mud of ponds and fresh water streams, the value of it depends upon the substances with which it is mixed. Where the water is resorted to by cattle, or fowl, or receives the washings of towns and farmyards, or even the drainage of a rich tract of country,

it will display considerable fertilising powers, and amply repay the expense of collecting. In the Netherlands, the gardeners maintain that the mud of canals and rivers is much improved in its quality, when it has been exposed, in small heaps, to a Winter's frost and a Summer's sun before being applied to the land."

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Fosseway, Lichfield, Oct. 17, 1879.

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